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Volume 22, Dec. 1957, Number 5

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THE JOURNAL OF SPEECH AND HEARING DISORDERS

Volume 22 December 1957 Number 5

Relation between EEG Pattern and Ease of Eliciting Electrodermal Responses
KIRTI K. CHARAN AND ROBERT GOLDSTEIN 651

What Is Zero Hearing Loss?
HALLOWELL DAVIS AND J. RICHARDSON USHER 662

Children as Guides to Teaching
JANE E. BEASLEY 691

Suggestions for Terms Applied to Electrophysiologic Tests of Hearing
ROBERT GOLDSTEIN AND A. J. DERBYSHIRE 696

Four Psychological Scaling Methods Applied to Articulation Defectiveness
DOROTHY SHERMAN AND CATHERINE E. MOODIE 698

Behavioral Rigidity in Speech-Handicapped Children
ERVIN KAPOS AND NICHOLAS A. FATTU 707

Stuttering as Conflict: 1. Comparison of Therapy Techniques Involving Approach and Avoidance
JOSEPH G. SHEEHAN AND ROBERT B. VOAS 714

The Frequency and Duration of Treatment Sessions in Speech Correction
EUGENE T. McDONALD AND JAMES V. FRICK 724

Problems in Military Audiometry: A CHABA Symposium
1. Introduction to the Presentations
J. RICHARDSON USHER 729

Problems in Military Audiometry: A CHABA Symposium
2. Veteran's Compensations for Hearing Loss
KENNETH O. JOHNSON 731

Problems in Military Audiometry: A CHABA Symposium
3. Diagnostic Audiometry
GORDON HOOPLE 734

Problems in Military Audiometry: A CHABA Symposium
4. A Classification of Hearing Tests
IRA J. HIRSH 736

Problems in Military Audiometry: A CHABA Symposium
5. Review of the 'Report by the Working Group on Military Audiometry'
RAYMOND CARHART 744

Problems in Military Audiometry: A CHABA Symposium
6. Automatic Audiometry
JOHN C. WEBSTER 748

Problems in Military Audiometry: A CHABA Symposium
7. Practical Limitations in Military Audiometry
ARAM GLORIG 750

Problems in Military Audiometry: A CHABA Symposium
8. Audiometry in the Armed Forces
THE CHABA COUNCIL 752

Noise Bands *vs.* Pure Tones as Stimuli for Audiometry
CECIL K. MYERS 757

The C. S. Bluemel Collection on Stuttering
ELWOOD MURRAY 761

Use of Palatography
PETER LADEFOGED 764

Formal Call for Papers 775

Book Reviews 777

Abstracts 786

News and Announcements 805

Index 809

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Relation Between EEG Pattern And Ease Of Eliciting Electrodermal Responses

Kirti K. Charan

Robert Goldstein

The use of conditioned electrodermal responses (EDR) to sound is gaining acceptance as a clinical tool for the measurement of auditory sensitivity. Nevertheless, there are references in the literature to the difficulty of eliciting electrodermal responses in some patients (*1*, *2*, *14*, *20*). In the authors' experience (*10*), it was more difficult to condition EDR in children whose auditory disorder may have reflected some defect of the central nervous system than to condition EDR in children whose hearing loss probably resulted from a defect of the cochlea or auditory nerve. Also, frequent difficulty was encountered in conditioning electrodermal responses in adults suspected of having a non-organic hearing loss (*9*). Difficulty of conditioning or depressed electrodermal responsiveness in general could not, however, be attributed simply to some physiological or psychological dysfunction. Observations on 32 normal children (*11*) revealed that nearly half of them were difficult to condition with the techniques used, and similar results were obtained in exploratory work with some normal adults. These observations on persons with normal hearing suggested that the extent of electrodermal responsiveness is related as much to some basic psycho-physiological trait which is characteristic of the individual as it is related to a specific pathological involvement or to the techniques used in any particular test.

The work of Lindsley (*12*, *13*), Darrow (*6*), and Mundy-Castle (*18*), among others, suggests that there might be a relation between the ease of eliciting any autonomic response, such as the EDR, and the pattern of the electrical activity of the brain as depicted in the electroencephalogram (EEG). Their work indicates that, in general, those persons whose EEG

Kirti K. Charan (M.A., Washington University, 1956) is a graduate student in Audiology at Central Institute for the Deaf and Washington University; Robert Goldstein (Ph.D., Washington University, 1952) is Research Associate, Central Institute for the Deaf, and Assistant Professor of Audiology, Washington University. This paper is based on Mr. Charan's Master's thesis and is adapted from a paper presented at the 1956 Convention of the American Speech and Hearing Association in Chicago. This study was supported by a grant (B-240) to Central Institute for the Deaf from the National Institute of Neurological Diseases and Blindness of the National Institutes of Health.

contains primarily low-voltage, fast activity, show more autonomic reaction to sensory stimuli than those persons whose EEG contains a dominant alpha rhythm (relatively high-voltage waves with a frequency of 9-11 per second).

The purpose of the present investigation was to compare the EEG pattern with the ease of eliciting electrodermal responses to sound in adults having normal hearing. The study was designed to determine whether what has been reported for autonomic responsiveness to sensory stimuli in general is also true for electrodermal responsiveness to sound in particular. Although the procedures involved conditioning of electrodermal responses, conditioning as such was not the subject under study. Conditioning was used mainly to insure that there would be sufficient responses to observe, and to simulate clinical situations during which many of the auditory stimuli are followed by electric shock.

Subjects

Sixteen men and 12 women between the ages of 17 and 41 served as subjects. All subjects, except one, had normal hearing. None of them had any known pathological condition of the nervous system or any serious emotional disturbance. They knew that conditioning of responses to tones would be attempted, but they were not aware of the exact procedures of the test.

The subjects sat in a reclining chair in a semi-darkened room while the experimenter operated the stimulating and the recording apparatus in another room. Pure tones and electric shocks were used as the conditioned and unconditioned stimuli, respectively. Simultaneous recording of the electroencephalogram (EEG) and the electrodermogram (EDG) was done on an electroencephalograph.

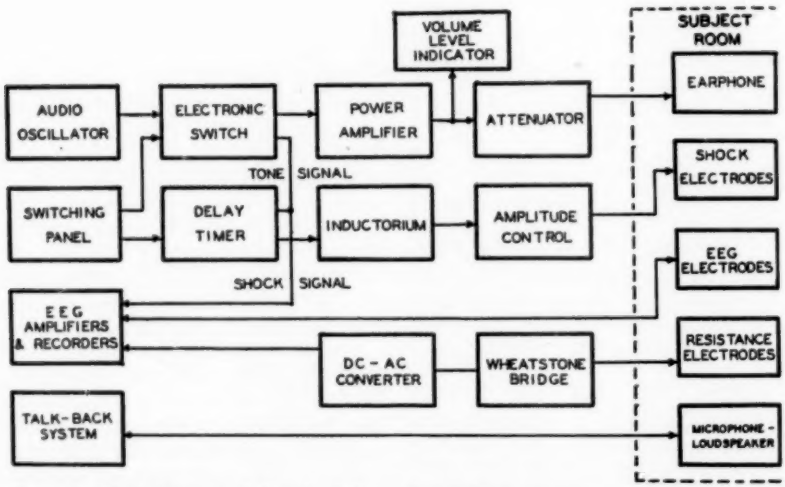

FIGURE 1. Block diagram of the stimulating and recording apparatus.

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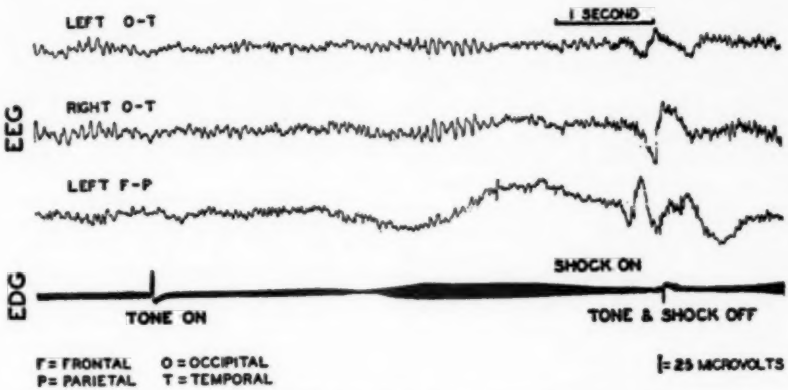

FIGURE 2. Sample electroencephalogram (EEG) and electrodermogram (EDG) with signal artifacts.

Procedure

Apparatus. The apparatus[1] described by Goldstein, Ludwig and Naunton (*10*) was used, except for minor changes in a switching panel. A block diagram of the apparatus is shown in Figure 1.

Conditioned Stimulus. The auditory signal was a 1000 cps tone, 20 db above the subject's threshold. Tones were presented to the right ear through an earphone. The left ear was covered by an inactive earphone. The onset and the end of the tones were recorded automatically on the recording paper (see Figure 2).

Unconditioned Stimulus. The shock electrodes and the apparatus which supplied the faradic current have been described in a previous study (*10*). The onset of the shock came 4.5 seconds after the onset of the tone. The tone and shock continued concurrently until the tone was switched off about 0.5 second later. The duration of the shock was indicated by an artifact in the record (see Figure 2). The tone and the shock stopped simultaneously. The shock was delivered to the calf of the left leg.

Recording the EEG. A Grass four-channel electroencephalograph was used as the recording instrument. In most cases electrodes were fixed to the scalp with fine-gauge needles which served as terminals. In a few cases, electrodes terminating in silver discs were applied to the scalp with bentonite paste and held in place with adhesive tape.

Recording the EDG. The electrodermogram (EDG) was recorded on the fourth channel of the EEG machine. The recording electrodes were small zinc plates, coated with a kaolin paste made with zinc sulphate; these

[1]The basic apparatus for this study was a gift of the Children's Research Foundation of St. Louis.

were taped to the tips of the second and third fingers of the left hand. The method used for recording the resistance and changes in the resistance of the skin with an EEG machine has been described by Mays (*15*), and by Goldstein, Ludwig and Naunton (*10*).

Preparation for the Test. The subject was seated in a reclining chair, and the shock and skin-resistance electrodes and the earphones were placed on him. The threshold for 1000 cps in the right ear was measured by conventional audiometry. The level of tolerance for shock (the level beyond which the subject felt that the shock would be unbearably painful) was also determined. Because reaction to shock is not the same for all individuals, shocks of equal voltage, current, or power were not applied to all subjects. Instead, an attempt was made to equate the effectiveness of the shock for each subject by establishing a level of tolerance for him.

The earphones were removed and eight EEG electrodes were placed on the scalp on the frontal, parietal, occipital and temporal regions of the right and left side, as described by Gibbs and Gibbs (*8*). Electrodes were also placed on both ears to provide the ground and the reference electrodes for monopolar recordings. The subject was instructed to relax and to keep his eyes closed. He was told that no shock would be given to him without prior warning. These instructions were necessary because any apprehensiveness on the part of the subject would have influenced his EEG (*12, 13*).

Monopolar and bipolar recordings of the EEG were taken from all electrode positions for about ten minutes. All four channels of the machine were used to record the EEG during this time. This procedure was repeated when the actual test was completed. The earphones were replaced and the subject was told that he would hear tones or feel shocks (or both). He was instructed to relax and to refrain from speaking or making any comment unless it was absolutely necessary.

The Test. A total of sixteen trials, six conditioning trials and ten extinction trials, were given. The time interval between successive trials was randomly selected from 30, 45, 60 and 90 seconds to avoid conditioning to a fixed time interval. The conditioning trials were not preceded by any adaptation trials; consequently, many of the electrodermal responses during the conditioning trials could have been unconditioned responses. No attempt was made to separate what might have been unadapted unconditioned responses from conditioned responses to tone.

The shocks were given at the following levels:

1st trial–80% of the dial setting for the subject's tolerance level.
2nd trial–90% of the tolerance level.
3rd to 6th trial–at tolerance level.

The first conditioning shock was not presented at the tolerance level.

Seward and Seward (*19*) have reported that repeated stimulation by shocks results in an adaptation to the feeling of the intensity of the shocks. Because the tolerance level was measured by an ascending method, some adaptation had already taken place when the judgment of the tolerance level was made. In preliminary studies it was found that most or all of this adaptive effect was lost during the 20 minutes which elapsed between the measurement of the tolerance level

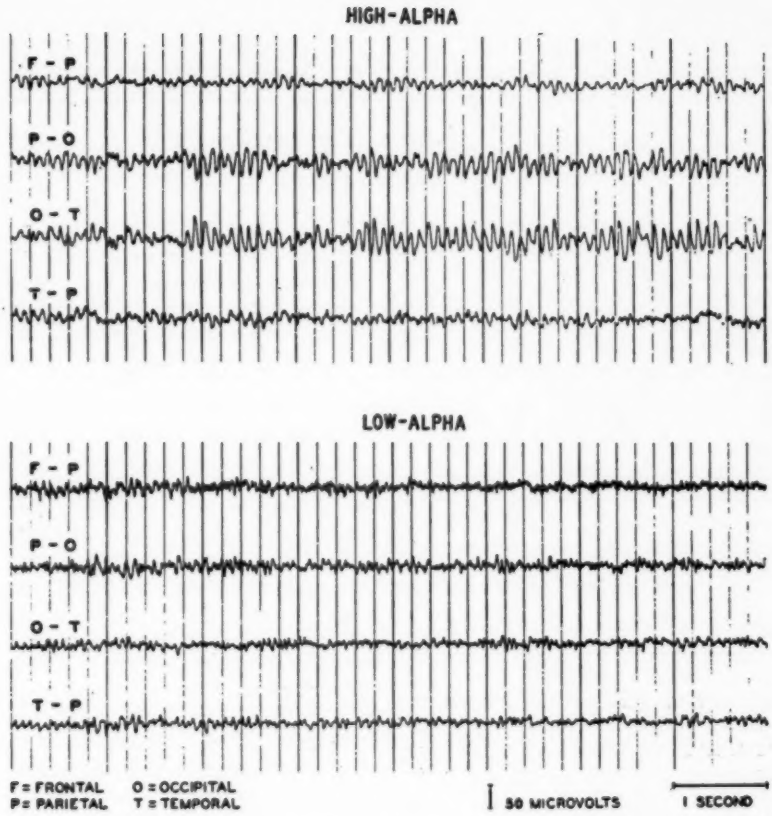

FIGURE 3. Sample high-alpha and low-alpha electroencephalograms.

and the beginning of the actual test. After such an interval, the presentation of the shock at the tolerance level was too painful for the subject.

Treatment of the Data. The EEG of each subject was placed in a high-alpha group or a low-alpha group. In only a few cases was it at all difficult to decide in which group a record should be placed. The high-alpha group included EEG patterns showing: high voltage (maximum amplitude greater than 50 μ V) 9-11 per second waves (alpha) present more than 50% of the time (see Figure 3). The low-alpha group included all

other EEG patterns. Low-voltage, fast activity, or mixed frequencies at low voltage dominate these records (see Figure 3).

There were ten men and seven women in the high-alpha group and six men and five women in the low-alpha group.

Changes in the resistance of the skin following the presentation of the 16 tones were analyzed, in order of importance, for: (1) latency of the change (a significant change usually began 2.0 to 2.5 seconds after the onset of the tone); (2) time course of the change (a response to the tone generally reached its maximum at a faster rate than the usual fluctuations in the baseline); (3) amplitude of the change (the change in resistance usually exceeded the amplitudes of the random fluctuations in resistance). If changes in resistance occurred with consistent latency, they were considered responses, even when they did not differ appreciably in time-course, or in amplitude from the random fluctuations in the baseline.

Judgments of electroencephalic responses (EER) depended only upon whether the EEG in the five-second interval during which the tone was presented differed clearly from the preceding pattern. Any striking change in the EEG was considered in making the judgment of responses. The usual changes, which have also been reported in other studies (*4*, *5*, *13*), were: (1) suppression of the 9-11 per second activity (alpha blocking); (2) increase in the fast activity; (3) a big, slow wave corresponding in length to a 3-5 per second rhythm (K-wave); (4) increase in the 9-11 per second activity. Besides these changes, there sometimes occurred very slow waves in the records (see Figure 2). These were not considered electroencephalic responses because they regularly coincided with the electrodermal responses in latency; as such, they were regarded as artifacts associated with electrical changes in the scalp due to autonomic activity (*12*). Motokawa (*16*, *17*), however, regarded these baseline deflections as EEG responses.

Results

Statistical Analysis. Because the findings indicate a clear difference between men and women in the relationship between the EEG pattern and electrodermal responsiveness, the data are not pooled for the entire group; instead, the findings for men and women are reported separately.

Among the male subjects, the mean number of electrodermal responses in the low-alpha group was significantly greater than that in the high-alpha group at the 5 percent level of confidence ($t = 2.65$ with 14 df).

Among the female subjects, the mean number of electrodermal responses in the low-alpha group was not significantly different from that in the high-alpha group ($t < 1$ with 10 df).

There were no significant differences between the mean number of electroencephalic responses in the high-alpha and in the low-alpha groups among either the men ($t < 1$ with 14 df) or the women ($t < 1$ with 10 df).

Graphic Representation. Figure 4 is a graphic representation of the electrodermal responses as a function of trials. The curve showing the percent of the group responding rises at first during the period of conditioning for the male low-alpha group and then falls off during the period of extinction. In the male high-alpha group, by contrast, the curve shows adaptation

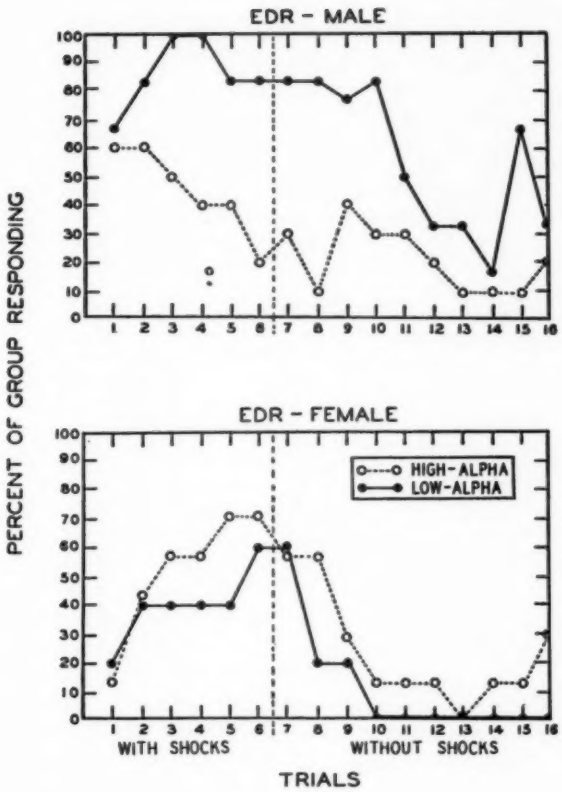

FIGURE 4. Electrodermal responsiveness, according to sex and EEG pattern.

from the start; that is, it is highest at the beginning and then gradually falls off. These two curves indicate that conditioning was taking place in the low-alpha group and probably not in the high-alpha group. It is conceivable that some conditioning was taking place in the high-alpha group and that adaptation would have occurred more quickly without the first six shocks.

Both high-alpha and low-alpha female subjects initially responded less frequently than the males. Both groups of female subjects seemed to condition appreciably, and both extinguished rapidly. Whereas the male low-alpha group responded more frequently than the male high-alpha group, the reverse was true for the females. There was no significant difference, however, in the average responsiveness of the two groups of females.

The EER resisted adaptation or extinction more than the EDR (see Figure 5). If a change is accepted in either the EDR or EER as a response to any of the 16 tones, a higher percent of the total group responding to each tone is found than if each kind of response is considered separately. It is concluded, therefore, that simultaneous observation of the EDG and EEG may be desirable clinically (*21*).

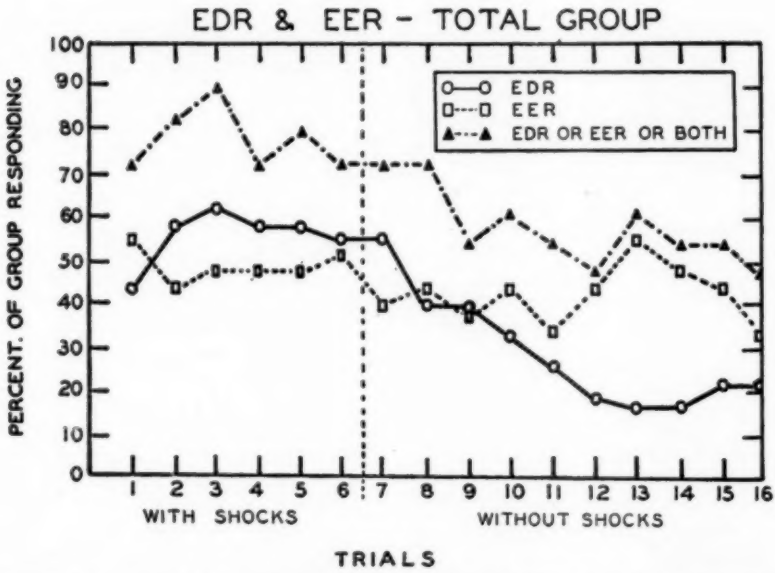

FIGURE 5. Percentage of total group giving electrodermal responses (EDR), electroencephalic responses (EER), or either or both.

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Discussion

We have found that there are adults as well as children (*11*) with normal hearing and behavior from whom it is difficult to elicit conditioned electrodermal responses to sound. In a study of normal children, a child was considered to be difficult to condition if he responded electrodermally to no more than ⅜ of the audible tones. Nearly half of the children were in this category. Although the procedures in the present study with adults differ greatly from the procedures used with the children, half of the adults were difficult to condition by the same criterion (responding to no more than ⅜ of the audible tones). On the basis of these observations and from clinical experience, we see no reason to doubt that the range of electrodermal responsiveness found in the experimental group is typical of the range in the total population of adults.

Davis and Davis (7) reported that 56% of their normal group of 50 adults had alpha rhythm present more than 50% of the time. This percentage was later approximated in another 110 normal adults. In the present study, 59.2% of the subjects are in the same high-alpha group, and, considering the small sample, the distribution on the basis of alpha rhythm seems quite normal.

If only the men are considered, the subjects in the low-alpha group show significantly more electrodermal responsiveness than is shown by the subjects in the high-alpha group. The difference between groups is most evident in trials three through ten (see Figure 4). It is not known that the relation between the pattern of the EEG and *conditioned* electrodermal responses is true for *unconditioned* responses as well. A report by Berry and Martin (*3*), however, does contain evidence for a high correlation between a subject's electrodermal responsiveness before and during conditioning, and before conditioning and during extinction.

Among the women, the low-alpha group was less responsive than the high-alpha group, but the difference in responsiveness is not significant. The group of women is too small to permit speculation about either the relation of EEG pattern to electrodermal responsiveness or about the differences in results between men and women. Nevertheless, Berry and Martin (*3*) do report a difference between the conditionability of men and women as functions of both instructions and apprehensiveness.

Conclusions

It may be concluded from this study that: (1) there are normal adults in whom it is difficult to elicit conditioned electrodermal responses to sound; and (2) the presence of a strong alpha pattern in a male may be inversely related to the ease of eliciting conditioned electrodermal responses; this relation does not hold true for females. The findings apply to normal adults; they may or may not apply to children.

Summary

The purpose of this investigation was to explore the relationship between the EEG pattern and the ease of eliciting electrodermal responses from adults with normal hearing. Sixteen tones of 1000 cps were presented at 20 db above each subject's threshold. The first six tones were followed

by electric shocks at the subject's tolerance level (conditioning trials). The last 10 tones were not reinforced (extinction trials). Simultaneous recordings of the subject's electroencephalogram (EEG) and electrodermogram (EDG) were made on an electroencephalograph. The subjects were divided into two groups on the basis of their EEG patterns. Ten males and seven females were in the high-alpha group (high-voltage, 9-11 per second activity present more than 50% of the time), and six males and five females were in the low-alpha group (primarily low-voltage, fast activity). Among the males, the low-alpha group gave significantly more responses on the average than the high-alpha group. There was an opposite, but not significant, trend for the females.

Acknowledgment

The authors are indebted to Dr. Robert C. Bilger, Research Associate, Central Institute for the Deaf, for the advice and assistance in the statistical analysis reported here.

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What Is Zero Hearing Loss?

Hallowell Davis

J. Richardson Usher

The present American Standard for normal hearing for audiometric purposes is set forth in the American Standard for Audiometers for General Diagnostic Purposes.[1] This standard has also been accepted earlier by the Committee on Audiometers and Hearing Aids of the American Medical Association. The adequacy and accuracy of this standard has been questioned repeatedly, however, particularly since the publication of recent British data (*5, 11*) that diverge significantly from the American Standard.

The entire problem of audiometric reference zero was reviewed at the 1955 CHABA Annual Meeting. The present article is based on the papers and discussions of that meeting, but, in addition to considerable condensation and some rephrasing, the present authors have added new material at several points.

Although the symposium was organized by a CHABA Working Group and was part of the program of the Annual Meeting of the Committee on Hearing and Bio-Acoustics, the opinions expressed are not necessarily those of CHABA nor of the CHABA Council. The Council hopes, however, that the publication of this article will facilitate the understanding, discussion and ultimate solution of the theoretical and practical problems of a possible new American Standard for Zero Hearing Loss.

CHABA is the Armed Forces-National Council Committee on Hearing and Bio-Acoustics. It is composed of civilian and military scientists who answer questions about hearing and bio-acoustics for the Armed Forces. The continuing services of the Secretariat are provided by the Central Institute for the Deaf under a contract with the Office of Naval Research. The contract is supported equally by

[1] Standards of the American Standards Association, Audiometers for General Diagnostic Purposes, Standard Z24.5-1951, New York, American Standards Association, 1951.

Hallowell Davis (M.D., Harvard, 1922) is the Executive Secretary of the Armed Forces-National Research Council Committee on Hearing and Bio-Acoustics and Director of Research at the Central Institute for the Deaf, St. Louis, Missouri. J. Richardson Usher (Ph.D., Cornell, 1951) is a Technical Writer at the Central Institute for the Deaf and Secretary for the Working Groups in the Secretariat of the Armed Forces—National Research Council Committee on Hearing and Bio-Acoustics. This report was prepared under Contract Nonr 1151 (Project NR 140-069) between the Central Institute for the Deaf and the Office of Naval Research (Project NR 140-069, Technical Report No. 13). Reproduction in whole or in part is permitted for any purpose of the United States Government.

the Army, the Navy and the Air Force. While most of its work is accomplished by small committees called Working Groups, it holds an annual meeting of the full membership to discuss problems of general interest. The 1955 Annual Meeting of CHABA was a two-day symposium on the broad topic of the testing of hearing in the Armed Services. Copies of the complete report of the Meeting may be obtained from the Office of Technical Services, Technical Information Branch, Department of Commerce, Washington, D. C. Those who qualify for the service may write the Armed Services Technical Information Agency, Document Center, Knott Building, Dayton, Ohio.

The Problem of a Reference Level for Zero Hearing Loss[2]

For the acoustic physicist, sound pressure level is a basic concept. For the psychologist, equal-loudness contour (including the threshold of hearing contour) is a corresponding basic concept. In medicine, both civilian and military, the corresponding basic concept is hearing loss.

These concepts are not independent, for each involves those from the more basic disciplines. Hearing loss is the most complex, because it involves a deviation of threshold from a 'normal' zero or reference pressure, measured in decibels.

The difficulties concerning the measurement and specification of hearing loss do not lie so much in the determination of sound pressure levels as they do in deciding what is the 'normal' threshold of hearing. It is in terms of this 'normal' threshold (or 'zero hearing loss') that audiometers must be calibrated, that physical standards must be written governing acceptance of personnel into the military services and that laws requiring compensation for injury to hearing by noise must be promulgated. It is for these practical reasons that the problem of zero hearing loss is of interest to CHABA.

Before the days of electric audiometers, the problem of defining normal hearing was simple. The otologist used a tuning fork as his sound source and his own ear as the reference standard. What he could hear, he believed his patient should also hear. The first electric audiometers were tried on small groups of individuals selected more or less at random from among the manufacturer's personnel. The average of their thresholds was accepted as 'normal' and became the zero of the hearing loss scale. Actually, the zero level of the Western Electric 2A Audiometer (established some 30 years ago) lies between the present American Standard and the new British Standard. As more companies began to manufacture audiometers, a national standard was required so that doctors could compare hearing losses measured on instruments of different manufacture. A national standard was evolved, but only with considerable difficulty because it was not clear just what was meant by the term 'normal hearing.' Now that the question of an international standard has become a real and urgent question, the term is still as obscure and ambiguous as it was twenty years ago.

Some people think the American Standard is 'right,' and some think it

[2]This section is based on the original presentation by Edwin B. Newman (Ph.D. Harvard, 1934), Chairman of the Psychology Laboratories at Harvard University and a past member of the CHABA Council.

is 'wrong.' In a broad way, the American Standard has at least the tacit approval of the American medical profession, but not of the professions in England or western Europe. It is, however, criticized by American psychologists and acousticians. But where is the difficulty? Is it a failure to agree on objectives? Is it a failure to agree on what is a normal person and how a group of such persons can be selected from the population? Is it a failure to agree on how the auditory signals are to be presented and what criterion of response or 'certainty of hearing' should be used? Is the alleged inaccuracy of the present American Standard due to poor acoustic conditions under which the basic measurements were made? Are the discrepancies that trouble us today due to faulty technique or logic in transferring the original standards to 'coupler pressures' and to earphones of a different design from that originally used? All of these questions, and many more, have been asked with increasing insistence over the last ten years.

Even without the additional confusion introduced by the adoption of a British Standard that differs from the American Standard, there has been a contradiction in American Standards. In America, the normal threshold of hearing is one thing for the otologist and another for the psychologist and the engineer. The otologist accepts the values for 'normal hearing' (his 'zero hearing loss') given in the American Standard for Audiometers for General Diagnostic Purposes. These are based on the United States Public Health Service survey (*3*), which employed the techniques of 'clinical audiometry.' But the acoustical engineer and the psychologist turn to the American Standards Association equal loudness contours. Here the zero loudness contour is based on Sivian and White's so-called 'laboratory threshold.' At some frequencies, the differences between these two 'normal thresholds' are as much as 20 db. The new British Standard actually agrees very closely with the ASA zero loudness contour.

Preview of the CHABA Presentations

This advance review attempts to indicate the orientation, the objective, the limitations imposed and the contribution made by each author toward answering one or more of the questions concerning the definition and establishment of a reference zero for audiometry.

In 1935-36, Dr. Beasley was in charge of the audiometric part of the United States Public Health Service Survey, and the present American Standard is based upon the resulting data. His account of the methods of selecting subjects, the precautions of measurement and the acoustic environment should allay many doubts that have been raised recently concerning these points. His present statements are important because the USPHS report series in which the original account appeared (*3*) is not easily available.

In regard to selection of subjects, he characterized his sample as a 'stratified sample of the general population.' It was not a random sample, but it can be taken as representative of the urban United States of 1930. From the larger National Health Survey a sample of about 5,000 persons, distributed as to age and sex, who had reported 'no hearing impairment' was given audiometric tests. The subjects had received no previous tests of this type. The data have now been analyzed by

age groups and criticism of neglect of the age factor is no longer justified.

Dr. Beasley's assurances as to calibration of the audiometers and the servicing of the audiometers in the field seem, to the present reviewer, to be fully satisfactory. The noise conditions in the audiometer booths can hardly be considered as a major source of error, even though octave-band analyzers were not then available. 'Noise audiograms,' as Dr. Beasley calls them, were made periodically on control subjects as assurance against error from masking.

The subjects were questioned on many items and the data were analyzed by statistical methods that would seem to protect against error from skewness of the distribution. Fundamentally, the value for normal hearing was determined by the modal, not the mean, value for the group. This value was read after the elimination of those who admitted to a recognized 'impairment of hearing,' as well as those whose audiograms 'deviated by more than 20 db at any frequency from the average for the entire group after skewness had been eliminated.' This seems to be in accord with the principles that Air Vice Marshal Dickson states have recently been adopted by the Acoustics Committee of the International Standards Organization.

Dr. Beasley also mentioned the steps by which the data obtained were expressed as a physical reference standard at the National Bureau of Standards in terms of coupler response. This procedure is somewhat involved, but was explained in some detail by Dr. Cook and subjected to critical review by Dr. Harris.

Air Vice Marshal Dickson reviewed the British studies that led to the adoption of a British reference standard for audiometers. The objective was to find a reference zero 'which expresses the state of hearing of persons free from any kind of hearing impairment.' The age group selected was from 18 to 25 years, although Air Vice Marshal Dickson said that in fact it would make little difference if the age group were extended to 30 years. Of course, one outstanding feature of the results is their divergence from the American Standard. At first glance, it would seem that British normal hearing is about 10 db more sensitive at all frequencies than American hearing. This explanation seems highly implausible, but has not yet been refuted by any direct test using the same methods and equipment. Neither has a single group of subjects been tested both in England and the United States by equipment calibrated according to the respective national standards. So far, we are still faced with the dilemma outlined by Dr. Newman.

Air Vice Marshal Dickson referred, however, to experiments in progress at the Walter Reed Army Hospital in which the U. S. National Bureau of Standards is collaborating and to British experiments in which cross-comparison of equipment is included. He stated that the Acoustics Committee of the International Standards Organization has agreed to await the results of these experiments before attempting to specify values for a possible International Standard. Actually, these results are not available at the time of writing (May, 1957).

In the general CHABA discussion on this topic, the important point was suggested that the British-American discrepancy may hinge on differences in the handling of the subjects. In the British studies a greater degree of relaxation and assurance may have been

achieved than in Dr. Beasley's survey and perhaps also a greater amount of practice in listening.

The account of the hearing survey conducted at the Wisconsin State Fair by the staff of the Research Center of the Sub-Committee on Noise in Industry (7) makes it clear that their data must now be considered as an important contribution to the specification of normal hearing. These data add to the USPHS Survey and to data collected in the World's Fair Survey in 1939 and in the San Diego County Fair Survey of 1948. The audiometry, the collection of medical, occupational and other information and the statistical handling of the data all appear to be fully adequate. Many of the procedures and precautions should serve as useful models for any future surveys of this sort that are undertaken. An interesting finding was a statistically significant difference between the hearing of men and of women. Dr. Grings gave some evidence that this may be due to exposure to noise and suggested that a history of noise exposure and of military experience is a factor in addition to age that must be considered in the specification of 'normal' hearing. It was not clear from his presentation, however, whether the Wisconsin Fair data more nearly support the American or British Standards for zero hearing loss. Dr. Grings and his colleagues were more concerned in this study with the influence of factors such as age, sex and noise-exposure on hearing. The absolute values of hearing thresholds were the subject of an important later study which is mentioned in the final summary.

Dr. Rudmose continued the discussion of the effects of age, previous noise-exposure and ambient noise on hearing losses as they are actually measured. He addressed himself, however, to a different aspect of the question of what is normal hearing. The statistical point of view, which must be adopted in setting the zero of hearing loss for audiometers by legislators in writing laws for workmen's compensation and by insurance companies in calculating their premiums, is different from the individual point of view held by the physician who must ask himself what is normal hearing for his particular patient. Are the physician's particular values contaminated by temporary threshold shift from recent noise exposure or from masking by excessive ambient noise during the audiometric test? Is it proper to use an average or modal figure to correct for age a hearing loss value that the physician has measured? Statistical values only allow the physician to make intelligent guesses. He must still struggle with the problem of the dispersion of statistical data. Where does his patient fall in the distribution curve for his group? The physician must carry in his mind a clear concept of not only the central tendency of what is 'normal hearing' for various groups, but also of the *range of normal.* Perhaps a 'hearing loss' shown by audiometry is not a loss in the sense that the patient has lost something that he once had. It may be that he was not fortunately endowed by nature and simply shows a *deviation from the American Standard* that is within normal limits.

Dr. Harris and Dr. Cook studied the problem of how to 'store,' as a physical standard for audiometry, the thresholds that are finally measured on the proper group of individuals under proper circumstances and by proper psycho-physical methods. Dr. Cook explained the principles and Dr. Harris summarized some of the

experiments he had done in his efforts to resolve the apparent discrepancies between the American or 'survey' standard and the British or 'laboratory' standard.

An important acoustical, and perhaps biophysical, problem is the transfer of voltage or sound pressure data from one type of earphone to another. Possible leakage under the earphone cushions is another. The possibility of using probe-tube measurements of pressure under the earphones at the entrance to the ear canal as the basic physical measure was considered at some length. Dr. Harris concluded, however, that, for some reason not yet identified, equal sound pressure level at the entrance to the canal does not necessarily yield equal loudness for different types of earphones. It seems possible that experimental or theoretical errors in transferring the standard from one type of phone to another and the use of slightly different couplers in England and in the United States may account for part of the discrepancy; but, in spite of many attempts to derive suitable corrective factors that will reconcile the two sets of data, the solution has not yet been reached. Dr. Harris finally concluded that 'one must search even more diligently for means to compose the differences. The best solution for the present seems to be to await the appearance of data on the same population, using two or more phones, with equivalent earphone-head coupling, probe tube calibrations, psychophysical method, *etc.*'

Dr. Cook told of the practical and theoretical problems involved in the present method of 'storing threshold information' by probe-tube pressure measurements and also by using a standard coupler or artificial ear. He concluded that the present method of storage and also of transfer from one phone to another is a 'cumbersome procedure.' He pointed out the advantages that would follow the design and adoption of a standard earphone and also of an artificial ear that would have the same impedance as the 'average' human ear and mentioned work in progress toward these objectives at the National Bureau of Standards.

The Basis of the Present American Standard for the Audiometric Reference Zero[3]

The hearing data obtained in the United States Public Health Survey of 1935-36 (*3*) forms the basis of the present American Standard for the audiometric reference zero, but the details of these data and the way in which they were collected and analyzed have been relatively unfamiliar to many workers in audiometry. This report aims to clarify certain crucial points. The information presented is in response to a series of specific questions prepared by CHABA Working Group 2. These questions concern the procedures and data of the United States Public Health Survey, 1935-36.

Population Studied. The population whose hearing was measured was not a random sample. It was a stratified sample of the urban population of the United States as of 1930. In this

[3]This paper is based on the original presentation by Willis C. Beasley (Ph.D., Ohio State, 1932), now at the Bio-physics Research Laboratory of the United States Public Health Service. He was invited to answer certain questions concerning the historic USPHS survey of 1935-1936 that collected the data on which the present American Standard for Audiometric Zero is based.

major National Health Survey, a total of 2,502,391 persons in 83 cities and 23 rural areas were enumerated. This enumeration yielded, among other data, statements by the subjects as to the state of their hearing. Subjects for the subsequent clinical study were selected from this pool on the basis of their own report that they had 'no noticeable difficulty with hearing.' This is the sense in which the sample was 'stratified.'

Within the above limits, care was taken to secure equal distribution by sex, a wide distribution by age and a wide diversity of occupation, education and economic background. The interest of the prospective subjects in the areas where the clinics were established was stimulated by letters, local publicity, personal visits and telephone calls.

Location of Studies. The studies were conducted in 13 cities. In four of these, two clinical units were operated. Altogether, there were seventeen audiometers and testing crews. The two-unit cities were Brooklyn, Cleveland, Detroit and St. Paul; the one-unit cities were Buffalo, New York; Brunswick and Atlanta, Georgia; Montgomery and Birmingham, Alabama; New Orleans, Louisiana; and in Texas, Houston, Dallas and Amarillo. Within cities, locations were variously downtown office buildings, hospitals and private dwellings.

Test Procedures. Each subject made only one visit to the clinic. The air conduction tests were made first, beginning alternately with right and left ears. The order of frequencies was 256, 128, 64, 512, 1024, 2058, 4096, 8192 cps and a recheck on 256 cps. The method of limits was used: threshold was approached twice from above and twice from below. The value entered for each series was the lowest intensity level at which the subject responded correctly twice out of three times to interruptions of the tone. Finally, the threshold was recorded as the 5 db step on the audiometer attenuator scale that was nearest to the average value for the several crossings. The threshold measurements were made on Western Electric 2A audiometers with 552W receivers.

Standards of Reference Used in Calibrating Equipment. The Bell Telephone Laboratories calibrated the type 552W air receivers before, during and after the survey. A conventional closed coupler was used and complete response-frequency characteristics were recorded. M. B. Gardner and H. C. Montgomery of the Bell Telephone Laboratories were employed on the USPHS staff throughout the survey. They trained and supervised the audiometricians, inspected and serviced the audiometers and kept a critical eye on all phases of the instrumentation and testing factors.

Control of Noise Level. All tests were made in uniformly constructed sound insulated booths. During the survey, 'noise audiograms' were made on control subjects inside and outside the booths, but a better estimate of noise levels was obtained after the close of the survey. Levels were measured at seven locations, thought to represent the worst and the best conditions with respect to ambient noise. The measurements were made with a calibrated sound level meter (Electrical Research Products, Type RA-224-C) loaned by the National Bureau of Standards. The ambient noise levels

averaged from 43 to 69 db. The overall attenuations of the booths ranged from 28 to 34 db. It was estimated from these data that the noise level inside the booths during the testing periods did not exceed the 45 db level and was usually between 35 and 40 db. Considering the additional seal provided by the air receiver pressed against the ear, it is not likely that noise level had any significant effect upon the auditory acuity measurements.

Preliminary Examination of Subjects. Experienced clinical otologists made a detailed ear, nose and throat examination of each subject, in accordance with written instructions. A detailed otological history card form was completed, covering all items relating to hearing impairments and family deafness.

Characteristics of the Final Standardization Group. The final standardization group was drawn from the total group of 4,662 persons (2,002 male, 2,660 female) who reported 'no noticeable difficulty in hearing.' No subjects were excluded from the final group because of 'associated conditions,' such as diseased tonsils, that might be thought to decrease the probability of normal hearing. Instead, an audiometric criterion was employed. This was 'an audiogram not exceeding a 20 db variation for all frequencies, with reference to the average characteristic of the distributions with skewness eliminated from the distributions for high frequency tones.' (The high-frequency tones are 4096 and 8192 cps.) Twenty-seven percent, or 1,242 persons, satisfied this criterion for both ears. A final criterion was that the equal and better ear combination should constitute the reference normal.

Present thinking favors the employment of the criteria of completely normal ear, nose and throat findings, a negative otological history and restriction by age to those less than thirty years old. We have, therefore, restricted the survey data and selected the 953 subjects (406 male, 529 female) who reported no noticeable impairment of hearing and who were 15-24 years old. Of these, 329 subjects (135 male, 194 female) had completely normal ear, nose and throat examinations and no significant history items. The means and the variances of this group did not differ significantly from those of the much larger reference normal group, except at 4096 and 8192 cps. Here the older group showed greater variance.

The Final Standards. Dr. Wilbert F. Snyder developed the physical reference standards from the clinical data at the National Bureau of Standards (1937-40). A closed coupler reference was first established in order to store the data obtained by the receivers used in the survey in terms of coupler response. Three of the receivers used in the original survey (with coupler calibration recorded at the Bell Telephone Laboratory) were used in establishing this laboratory reference. When this was completed, threshold acuity measurements were defined in terms of the voltages required across the receiver terminals to produce a given pressure in the couplers.

In 1939, the coupler standard was changed to the WE-705A earphone, for reasons of improved stability. In doing this, a loudness balance method was used, in which an observer adjusted the voltage applied to one of the 705A receivers until the sound

appeared to be as loud as that produced by the standard 552W earphone when the latter was operating at a known level. This procedure was followed at the observer's threshold and at 20 and 40 db above his threshold. Six observers participated in these measurements. The voltages which must be applied to the 705A earphones to produce the reference normal threshold were obtained from these measurements. The three 705A earphones used in these measurements then became the standard for calibrating audiometers. No significant change has since occurred in the basis for the American Standard.

The New British Standard for the Audiometric Reference Zero[4]

Work on a threshold standard began just before the last war through a request to the British Standards Institution by the Section of Otology of the Royal Society of Medicine for the preparation of suitable performance standards for audiometers. Immediately following the war the question was studied by the Electro-Acoustics Committee of our Research Council. Full consideration has been given in the United Kingdom to the reference standards for audiometric zero which have been adopted in the United States, but two questions continually arose. First, the American standards were not expressed in nor were they easily convertible to the terms of the measurement procedures current in the United Kingdom. Second, there appeared to be a growing opinion on the part of otologists in the United Kingdom that the American reference zero was 10 db too high, perhaps even more. In other words, the United Kingdom otologists consider that the normal ear is about 10 db more sensitive than is implied by the American reference zero. This point of view has also been expressed fairly consistently by European otologists.

It has frequently been suggested that it is really immaterial what standard of reference is adopted for audiometry, provided the standard is expressed unambiguously in terms of objective measurements. However, if the otologist finds in his own experience that this reference zero does not correspond with the hearing of normal persons, he will tend to adopt a reference zero which more nearly reflects his own clinical experience. As a result, an arbitrary reference zero would not be generally accepted and would be of little value as a standard measurement criterion.

A fundamental determination of the threshold of hearing when using an earphone was undertaken at the National Physical Laboratory and not long afterwards the Central Medical Establishment of the Royal Air Force undertook a similar investigation.

The group selected by the National Physical Laboratory for testing met two general requirements: (1) no defect in hearing or hearing pathology, as determined by an otologist; (2) age group, 18-25 years. This last requirement eliminated the older people, who are subject to presbycusis. While presbycusis is a 'normal' development for most people as they grow older, it is still a loss in hearing. In

[4]This section is based on the original presentation by Air Vice Marshal E.D.D. Dickson (C.B., C.B.E., M.D., F.R.C.S., Q.H.S.) of the British Royal Air Force Central Medical Establishment. Marshal Dickson spoke for himself and his collaborators, Mr. R. S. Dadson and others, who have recently published important new data on normal hearing (*5, 9*).

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addition, presbycusis not only does not appear in everyone, it appears in varying amounts at different frequencies and would therefore greatly complicate the specification of reference sound levels at the higher frequencies.

Having determined the threshold voltages for a particular pattern of earphone the corresponding information for other patterns of earphones is obtained by equal-loudness balancing at a fairly low sound level. Various patterns of earphones employed for audiometry have been calibrated at the National Physical Laboratory using this procedure and the method has proved both reliable and straightforward. The alternative method of using probe-tube microphone measurements in human ears, advocated by the American National Bureau of Standards, appears to be far more complicated and to have more numerous possibilities of error. In addition, when earphones with differently shaped cavities are compared by this method, a measurement at a single point in the outer ear is not adequate to specify the sound transmitted down the ear canal, unless the measurement point is located very close to the entrance to the meatus. Making such a probe-tube measurement is difficult and laborious compared with the method of equal-loudness balance.

In 1952, two articles on threshold measurements were published by British authors, one by Dadson and King (*5*) of the National Physical Laboratory and the other by Wheeler and Dickson (*11*) of the Royal Air Force. The results of these two investigations came out at levels some 10 db or so below (or *more* sensitive than) those of the American Standard. It is interesting to note, however, that they agree much more closely with the original curve of minimum audible pressure published by Sivian and White in 1933 (*9*). Within the limits 250 to 8000 cps, which is the range of most importance in audiometry, the British results are within ±5 db of the minimum audible pressures given by Sivian and White and the average discrepancy over this frequency range is in fact only about 0.5 db. Recently, the National Physical Laboratory and the American National Bureau of Standards have done comparative work to determine the cause of the real difference in American and British results. These studies have reaffirmed the difference and show that it averages 10 db across the audiometric frequency range. It is not a constant difference, however, but varies between 5 and 15 db according to the frequency.

The assignment of definite reasons for these very large discrepancies is quite difficult. Very careful reconsideration has recently been given to the accuracy of the British determinations, both in regard to the objective basis of measurements and the psychophysical procedures adopted. The result of this recheck agrees with the original investigation to the order of 1 db error. There is absolutely no possibility in this work of errors comparable to the 10 db discrepancies mentioned above. The combined results of the British investigations and the recent recheck have now been accepted by the Acoustics Standards Committee of the British Standards Institution as a basis for a British Standard. The Standard (No. 2497: 1954) is now currently used in the United Kingdom and is the basis of all audiometer calibrations carried out at the National Physical Laboratory. Since its publication, the Standard

has been formally adopted by the British Association of Otolaryngologists.

The consensus in the United Kingdom is that the determinations carried out in the course of the United States Public Health Survey in 1935-36 represent, on a comparative basis, an excellent survey of the hearing of the American population. Some doubt exists, however, as to whether the objective procedures of measurement and the physical aspects of that investigation were sufficiently accurately specified for the purposes of an *absolute* standard. For the latter purpose the measurements need to be conducted by a staff that is skilled and experienced in some of the more difficult aspects of acoustic measurements, and the resources of a properly equipped standards laboratory must be virtually on the spot for continual reference.

There is one respect in which the present American Standard does not appear to be explicit. The Standard states the threshold pressures, measured in a 6 cc coupler, corresponding to the threshold excitation of a particular kind of earphone at a series of frequencies. It does not state, however, the force of application of the earphone to which these figures relate. There is no doubt that the acoustic pressure set up in the human ear by an earphone is quite strongly influenced by the force of application; without this information the standard is bound to be ambiguous.

Reference has been made in some United States publications to somewhat large forces of application for earphones, such as 1,000 to 2,000 grammes. Forces of application of this magnitude are unnecessarily great and are bound to involve discomfort on the part of the subject. There is a question as to whether proper threshold measurements can be made by subjects whose ears are exposed to forces of this magnitude.

The possibility must be considered, remote though it may seem, that American and British subjects differ as to their acuity of hearing. Such an explanation can only be accepted as a last resort when all other possible sources of error have been carefully excluded. A number of other surveys in this same field have now been or are being carried out in the United States, one of which has now been published by Harris (*8*). The latter publication seems to indicate a tendency towards values which are closer to the British measurements.

Since the completion of the British work on the threshold of hearing by telephone listening, further evidence has been obtained at the National Physical Laboratory which very strongly confirms the general accuracy of the original measurements. In the course of a re-determination of the equal-loudness contours in free field, threshold of hearing measurements have been made on a team of some 120 subjects. The conditions adopted were those of an observer facing the source of sound and listening with both ears. It has been known for some time that the minimum audible free field threshold lies below the minimum audible pressure by telephone listening but, apart from effects due to diffraction round the observer's head, is roughly parallel to it. The difference between these two thresholds has been popularly referred to as the 'missing 6 db.' The National Physical Laboratory results show this effect very clearly and, apart from the diffraction effects already mentioned over the upper half of the frequency range, they show in a most

consistent manner the general parallelism between the two types of threshold.

The British Committee recently approved the British Audiometric Standard and considered delaying the issuance of its final report until some attempt had been made to reach international agreement on the placing of the reference zero. The standard was issued, however, because of British needs for a standard and because the reaching of an international agreement on this subject might be indefinitely delayed. Discussions on this topic have been initiated by the British Committee at the meeting of the Acoustics Committee of the International Standards organization which was held in Berne, Switzerland, in September 1955. The Acoustics Committee discussed at length the various requirements which the proposed international reference zero should satisfy. It was agreed that: (1) the reference zero should be based on persons free from any kind of otological defect and included within the age limits of 18 to 30 years; (2) an additional limitation should be placed on the group by restricting consideration to individual thresholds lying within ± 15 db of the modal value; and (3) the value of the threshold level adopted should be the modal value of the distribution.

Summary. The reference standard for audiometric zero of the British Standards Institution is based on studies by the National Physical Laboratory and the Central Medical Establishment of the Royal Air Force. This standard does not deviate more than ± 5 db at any one frequency from the minimum audible pressures given by Sivian and White and the average discrepancy over the range from 250 to 8000 cps is much less. The British Standard for the calibration of audiometers thus differs considerably from that employed by the National Bureau of Standards in the United States.

The Wisconsin State Fair Survey[5]

In August of 1954 a State Fair was held in Wisconsin and the opportunity was presented to obtain support for another survey on hearing. It was decided to plan the work to add as much information as possible to that gained from the 1935-36 U. S. Public Health Survey, the World's Fair Survey of 1939 and the 1948 San Diego County Fair Survey.

Test facilities available at the Wisconsin State Fair made it possible to add information to that previously collected in other surveys. These facilities were: (1) space and personnel for the collection of a relatively complete medical and occupational history on each person observed (It was hoped that in this manner factors in the life experience of the

[5]This section is based on the original presentation by William W. Grings (Ph.D., Iowa, 1942) who is at the University of Southern California and is also in charge of the statistical work at the Research Center of the Subcommittee on Noise in Industry in Los Angeles. He was invited to tell, from the point of view of the statistician, how hearing data relevant to the problem of 'what is normal hearing' should be collected and what was actually done at the Wisconsin State Fair Survey of 1955 (*4*).

The data of this survey are available in detail in a monograph entitled: '1954 Wisconsin State Fair Survey—Statistical Treatment of Clinical and Audiometric Data,' Glorig, Wheeler, *et al.*, published as a monograph supplement of the Transactions of the American Academy of Ophthalmology and Otolaryngology.

ears, such as exposure to noise, could be evaluated.); (2) an ideal environment for testing by trained technicians with optimally calibrated equipment; (3) equipment for testing each person for both pure tone thresholds and speech reception.

Space for the testing was provided in one of the large exhibit buildings. A special shell of eight-inch-thick concrete blocks was built inside an existing room which was previously used as a theatre. The shell was 40 x 14 feet at the base and 12 feet high. Inside the shell were located eight prefabricated test booths which were provided by the Industrial Acoustics Company of New York. The average noise level in the test booths was well below those under consideration by the American Standards Association as being suitable for audiometry.

Pure tone audiometers were supplied by the Maico Company of Minneapolis. Speech audiometers were provided by the U. S. Recording Company of Washington, D. C. Each audiometer was calibrated by the manufacturer just prior to use and was checked by voltage measurement and 9A coupler calibration three times during the Fair. PDR-10 phones were used, equipped with MX 41/AR cushions. Every morning before the testing began, a biological check on the calibration was made, using a selected group of ears. Finally, at the end of the survey, all the pure tone audiometers and one speech audiometer with all the constant level recordings were calibrated at the laboratory of the Central Institute for the Deaf.

Students from the Milwaukee State Teacher's College Department of Audiology performed the testing. Even though each student had received previous training in audiometry, each was checked out by the research staff prior to the study.

The order of testing right and left ears was arranged so that the right ear was tested first on half of the subjects; on the other subjects the left ear was tested first. Frequencies were presented in standard order: 1000 cps first, then 1500, 2000, 3000, 4000 and 6000 cps; then 1000 cps was retested, followed by 500 cps. A comparison was made of the first and second testings at 1000 cps. A significant difference was noted in the retest at 1000 cps on the first ear tested but not on the second ear tested.

Each subject was examined by a physician, usually an otologist. A detailed medical, social, educational and occupational history was obtained by questionnaires and special interviews. An interviewer obtained descriptive information about the subject's occupational environment, difficulties in communication and items related to education and language environment in the home. The subject himself recorded his age, place of residence and occupation, military service history, *etc.*

A total of 3,478 persons was tested during the nine days of the Fair, of which 1,731 were females and 1,747 males. To provide some estimate of the representativeness of the sample, the census figures for Wisconsin in 1950 were consulted. It was concluded that the survey provided a representative sample of ages from Milwaukee County, but not from the State of Wisconsin. There was a representative division of males and females, and a somewhat higher average education than that found in the last Wisconsin census.

There was a significant difference

TABLE 1. Threshold for 1954 Wisconsin State Fair. Reference is median of total sample, males only.

	*Total Sample**			*Restricted Sample†*		
Frequency	*Mode*	*Median*	*Mean*	*Mode*	*Median*	*Mean*
500	-5	-0.8	2.3	-5	-0.8	0.6
1000	0	1.8	5.0	0	1.0	1.5
1500	0	2.0	5.0	0	0.7	0.9
2000	0	2.4	5.4	0	0.8	1.7
3000	5	5.0	9.4	0	2.8	5.1
4000	5	7.0	12.7	5	4.7	6.5
6000	5	12.6	16.9	5	9.5	11.7

*(N = 193)
†(N = 72)

for both men and women between right ears and left ears, with better hearing in the right ear. Many hypotheses have been formulated to explain this unexpected difference, but none has proved satisfactory. The difference seems to be real and unexplained. A different zero reference level would emerge if right ears only, left ears only, both ears of all subjects, or the better ear of each subject were chosen. For preliminary analysis, the zero reference level chosen (arbitrarily) was the *median* of the 18-24 year-old subgroup.

There are clear trends in average hearing losses that relate to both age and sex. Hearing losses increased progressively, decade by decade, with the higher frequencies showing more loss than the lower. In addition, the losses for men are generally greater than those for women. The differences between men and women are significant for all age levels.

In an effort to find the basis or bases for these differences and to facilitate comparison of the data with those from other surveys, the population samples were restricted. The criteria for restriction were that no persons were included who (1) had worked in a factory or had been exposed to noise of specified levels, (2) had been in military service, (3) had trouble with his ears or difficulty in hearing, (4) had an occluded auditory canal or a perforated or diseased eardrum, or (5) had a history of discharge from the ear.

A common procedure in handling this type of data is to employ the mean instead of the median, but to restrict the sample to subjects whose hearing does not deviate more than 20 db from the mode of the basic group. According to this rule, the means for the restricted and for the basic sample of the 18-24 year age group were calculated. The means, the medians and the modes for males only are shown in Table 1. The differences among these measures are relatively large for the total sample, but are small for the restricted sample.

The hypothesis was formulated that the previous exposure of the ears to noise, a significant non-disease factor, might influence auditory sensitivity. A study was therefore made of diverse groups of workers. The audiograms for 40-49 year old men working in offices and for those working in factories were compared. The fac-

tory workers showed 5 db more loss at 500 cps, 10 db more at 2000 cps and nearly 19 db more at 4000 cps. The difference between office and factory workers increased progressively with age and all of the differences by age were statistically significant except between the two lowest decades.

Some trends were also found that seem to relate the degree of hearing loss to previous military service and to the noise levels associated with various occupations. The latter relation was, however, only statistically significant for rather quiet versus extremely noisy occupations.

In conclusion, these data strongly suggested that there were several factors which must be considered in the definition of 'normal' hearing. A history of noise exposure and military experience were likely factors. To these should be added a variety of medical factors, and appropriate statistical procedures must be employed.

The Influence of Masking Noise, Age and Previous Noise Exposure On the Audiogram[6]

The hearing loss shown on any audiogram may be a composite of the effects of: (1) masking effects of ambient noises in the test environment; (2) presbycusis; and (3) previous noise exposure, which causes temporary threshold shift and persistent or permanent hearing loss.

In the industrial sense, the most important kind of hearing loss is the persistent, and perhaps permanent, hearing loss caused by noise exposure. The term 'persistent hearing loss' is a new term that indicates a threshold shift that persists after a day or two of absence from noise but which is not necessarily permanent. 'Permanent hearing loss' has a medico-legal connotation and its determination involves diagnostic procedures and evaluation by a qualified physician. Therefore, in the present context of surveys and statistics, the term 'persistent hearing loss' will be used. This term does not raise the question of permanency. In determining how much persistent loss a person has, the other effects must first be evaluated and subtracted from the audiogram. As will be shown, the extent of these other effects can be estimated statistically much more easily and quickly than they can be definitely measured in the individual. It is in this application of statistical concepts to individuals that the major difficulties lie in correcting audiograms for the influence of age and previous noise exposure.

Undue noise present in the audiometric test environment has the effect of 'masking' or hiding the individual's true hearing threshold, resulting in a spuriously high threshold audiogram. Where the ambient noise in a test room is still above the masking level for persons with normal hearing, a group of young persons who have not been exposed to noise may be used to control the accuracy of the audiometric readings. The means of audiograms of the control group taken in

[6]This section is based on the original presentation by H. Wayne Rudmose (Ph.D., Harvard, 1946) of Southern Methodist University, who was Technical Counsel to the Z-24 Subcommittee of the American Standards Association which prepared the report on the relations of hearing loss to noise exposure (Rosenblith, W. A., *et al.* The relations of hearing loss to noise exposure. Report of the Z-24 Subcommittee of the American Standards Association Z-24 Sectional Subcommittee, 1954).

the test room are compared with means of their audiograms taken elsewhere under satisfactory conditions. The difference shown, which will probably be chiefly in the lower frequencies, is the amount of masking caused by the noise in the test environment. If this difference amounts to 10-15 db, the noise in the test room must be reduced before the room is used for monitoring audiometry. Ideally, no difference should be tolerated, but monitoring audiometry is chiefly concerned with measuring changes in the hearing of ears that have already reached the upper limit of the normal range, so small differences do not affect the accuracy of the readings.

Presbycusis, which is the otherwise unexplained loss of hearing that comes with advancing age, is now of considerable interest because its effects cannot be separated by measurement from those losses which occur from exposure to noise. The 1955 Wisconsin State Fair Survey was particularly interested in gauging the effects of presbycusis upon hearing and its incidence in the older age groups. The Survey measured the hearing of a large, representative sample of the population attending that Fair and selected, for purposes of the presbycusis studies, a reasonably large sample of men who had no history of ear trouble, who had not been exposed to loud noises and who had shown no outer ear pathology upon examination. The audiograms of this group were sorted into age decades and analyzed to compare the losses experienced by each age group. A statistical study was made to determine the distribution of hearing losses among these males who had no apparent reason, other than age, for showing a hearing loss. The results, which indicate a clear trend of increasing loss of auditory sensitivity with age, are reported in full elsewhere.

For the 20-29 age group in this study, the small spread about the median loss at 4000 cps showed the median to be quite representative of the hearing of this age group. For the 40-49 age group, however, the spread about the median was very large. The medians are only statistics and represent an 'average man' who does not exist.

For *legal* purposes, since there is such a variability in the amount of hearing loss resulting from apparently similar noise exposures, often the best that can be done is to compare a given individual with this statistical 'average man.' While this may be unfair to the individual, it is done because there does not seem to be any better way to assess his condition relative to other people. For *medical* purposes, statistical medians are of great help in indicating expected trends and will tell the physician how many noise susceptible individuals he may expect to find in a given group. These statistics will not, however, tell him *which* individuals in the group are susceptible. Simply because an individual over 45 shows a large hearing loss does not justify the conclusion that it was due to something other than old age. However, if a group shows a median hearing loss that is much different from that shown by an appropriate reference group, then, *as a group*, the loss is due to something other than age.

Exposure to loud noise will result in a temporary threshold shift, and if the exposure is long enough and strong enough, in a persistent hearing loss.

Temporary threshold shift is defined as that transient loss of hearing, lasting perhaps as long as two days, that occurs as a result of exposure to noise. There is some question about just how long a person should be away from the noise environment to allow this effect to pass off before his audiogram is taken. Glorig, of the Subcommittee on Noise in Industry, has stated that

> 'If a man has been exposed to noises with octave band levels of slightly less than 100 db, then 20 to 30 minutes away from the noise-exposure will reduce his threshold shift to approximately 5 or 10 db. Under these circumstances some persons will show up to 20 db temporary threshold shift, (TTS), but the average shift will be 5 to 10 db.
>
> As a rule, younger persons seem to show the largest amount of temporary threshold shift. If a person already has a 25 to 30 db permanent hearing loss, his temporary threshold shift will be less than the TTS found in a person with less permanent hearing loss; therefore, the amount of TTS remaining after 20 minutes off the job will be less in persons with 25 to 30 db permanent hearing loss.'

The above statements indicate that we are again dealing with a statistical concept which will tell a great deal about a group, but very little about a given individual. Using this statistical information, however, will help us to make an intelligent guess as to how much of a measured hearing loss is really temporary threshold shift. When the calculated effects of masking noise, presbycusis and temporary threshold shift have been subtracted from a given individual's audiogram, any hearing loss remaining that exceeds the criterion for normal hearing is that person's persistent hearing loss. Data now exist which give the median losses to be expected in male and female reference groups as a function of the age of the group, but presbycusis losses expected statistically for men do not apply to women. Statistical studies can be made of industrial audiometric data to determine whether the employees in a given age group exhibit median losses in excess of those due to age alone and which ones might be attributed to noise exposure or other cause.

Summary. If, in an industrial situation, small threshold shifts due to masking noise in the test room are suspected, a control group should be used. If the audiometric losses in the control group show that masking effects are present but are not over 10 db, apparent hearing losses of a small amount may be considered spurious and be disregarded. Greater losses, however, are significant. If masking due to room noise is greater than 10 to 15 db at any test frequency, the noise should be reduced.

Statistically speaking, temporary threshold shifts will be small, of the order of 5 or 10 db, if the noise level is less than 100 db in every octave band and if the subject has been away from the noise for fifteen or twenty minutes before his audiogram is measured. The largest temporary threshold shifts occur in young people who have small or no persistent losses.

When the disturbing effects due to masking noise, presbycusis and temporary threshold shift have been subtracted from an audiogram, any re-

maining deviation from normal is the amount of persistent hearing loss.

Steps Toward a Physical Standard of Reference[7]

Pure tone audiometry is used to measure the threshold of hearing. The primary question today concerns how the sounds are measured and whether the method can be proved accurate. Accurate methods of measuring must precede, or at least accompany, any standards that are developed.

The eardrum reacts to sound waves in a manner proportional to the sound pressure level in the air rather than to the motion of the air particles. This means that sound pressure level is the physical quantity of prime importance in the measurement of hearing. For audiometric purposes, sound pressure level should be measured over a frequency range beginning at 125 cps and continuing up to 6000 or 8000 cps. The sound pressure at threshold ranges from a least value of approximately 1/1000 of 1 microbar at a frequency of 1000 cps to about 1 microbar at the very low frequencies.

There are several ways in which the sound pressure can be measured. Agreement has yet to be reached as to which of these methods should be used. In one way, the 'free-field' method, the sound arrives at the listener as a progressive plane wave and the sound pressure level is measured at the head location, with the listener absent. A much more convenient method, favored by otologists, uses an earphone to produce sound pressure

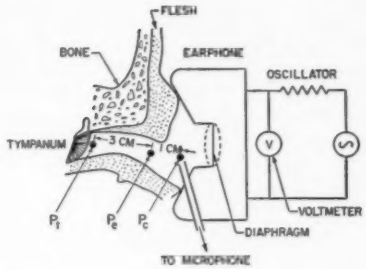

FIGURE 1. Acoustics of Earphone—Ear System.

in one ear canal. Measurements of the sound pressure level might be made in the ear canal, but rarely are, for reasons which will be discussed shortly.

Figure 1 shows an earphone applied to the ear. Voltage applied to the terminals of the earphone by the operator can be adjusted both in amplitude and frequency. An audiometer is, of course, nothing more than just this combination of an earphone and an oscillator with an attenuator to vary the sound pressure level generated.

Several technical points must be discussed before considering the more purely audiometric questions. Because of the electric circuit noise present in the probe-tube microphone shown in Figure 1, the sound pressure level is not measured at the listener's threshold of hearing. Measurements are made, instead, at a relatively high level, about 65 db above threshold at some frequencies. The voltage required to produce the appropriate sound pressure level is reduced by a known factor down to what would be the threshold reading. The SPL is also attenuated by the same factor.

The foregoing calculation is a plausible first assumption, since the amplitude of small acoustical vibra-

[7]This section is based on the original presentation by Richard K. Cook (Ph.D., Illinois, 1935) of the National Bureau of Standards, whose specialty is the physics of sound. He is in charge of the section that is responsible for acoustical standards.

tions is usually a linear function of the exciting force. It is conceivable, of course, that the tension in the muscles of the middle ear might be influenced by the sound pressure, even at low levels, just as it is at very high levels and the acoustical impedance of the ear canal might, therefore, change with sound pressure level. This would mean that the sound pressure would be attenuated by amounts different from the voltage on the earphone. It is estimated, however, that sound pressure at threshold, as calculated from the measured sound pressure at one microbar and the attenuation required for the corresponding earphone voltage for each threshold, will differ from the actual sound pressure in the ear canal by much less than 5 db.

With practical earphones now in use, and for a given voltage applied at one of the audiometric frequencies, the amplitude of motion of the diaphragm in air under normal conditions is practically independent of the size of the acoustical impedance which is seen by the diaphragm, at least for audiometric purposes. Therefore, the sound pressure, P, produced inside the ear canal by a given earphone is inversely proportional to the acoustical impedance, Z, seen by the diaphragm. ($P = \text{a constant} / Z$). The impedance of the earphone-ear-canal combination varies appreciably from person to person; therefore, the sound pressure produced in the ear-canal will vary from person to person, even though the voltage and frequency applied to the given earphone are held constant. At low frequencies, the sound pressure will be the same at all points within a particular ear canal. For the higher audiometric frequencies, however, there might be considerable variation in the sound pressure at various points in the canal because of the distance between the diaphragm and the tympanic membrane. For example, suppose the distance from the diaphragm to the membrane is five centimeters. If the diaphragm produces sound of a wave length of ten centimeters, a standing wave might be set up in the ear canal. Both the sound pressure at the tympanum and that near the diaphragm could be considerably greater than what would be expected from the simple formula given above. A wave length of ten centimeters corresponds to a frequency of approximately 3500 cps. Indeed, experiment shows that the real-ear response, which is the ratio of sound pressure to voltage, varies from ear to ear and also depends on the type of earphone.

From the foregoing it appears to be desirable to measure sound pressure somewhere in the ear canal. But this is never done in routine audiometric practice. What is actually measured, or indicated by an audiometer, is the voltage at threshold. It is this quantity which has been measured in the various threshold surveys on which the English and the American standards are based. The prime threshold data are so-called threshold voltages, at various frequencies for each individual, at the terminals of a particular earphone. The *standard* threshold voltages are a suitable statistic, *e.g.*, mode, mean, or median of the prime data.

The problems are how to transmit best the standard threshold information to researchers, manufacturers of audiometers, *etc.*, how to protect the threshold information against the damage or complete loss of the earphone and how to make allowance for the variation of the sound power output (per unit voltage input) with

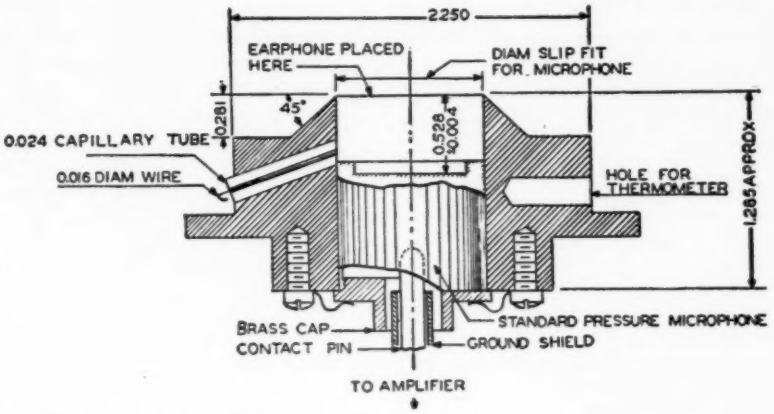

FIGURE 2. American Standard Coupler, NBS type 9-A.

time. The last problem is sometimes called 'aging' of the earphone and its general effect is to change the threshold voltages.

All three of these problems have been solved by the introduction of a standard coupler, or artificial ear, for measuring the sound pressure produced by an earphone when threshold voltages are applied to it. The audiometric coupler which is standard in the United States is shown in Figure 2. A different coupler is standard in Great Britain. The basic idea is that all earphones of a particular pattern, which we may call type S, will have the same ratio of sound pressure in the ear canal to sound pressure in the coupler for a given voltage at the earphone terminals, even though the responses may be different because of manufacturing variations, aging or damage. The coupler is used in the folowing way: the standard type S earphone, with threshold voltages applied to it, is placed on the coupler. The sound pressures which are produced are called the 'coupler standard threshold pressures.' The threshold voltages of another earphone of the same type S (or of the standard earphone, in case it has aged or been damaged) are obtained by placing the earphone on the coupler and finding the voltages which produce the coupler standard threshold pressures. The coupler thus serves as a device for 'storing' threshold information.

When we wish to find the threshold voltages for an earphone of a different type, *e.g.*, type T, the coupler threshold pressures for type S cannot be used. But a transfer can be made by loudness balancing. A group of about ten persons determines the voltages which must be applied to a type T earphone so as to produce the same loudness as a known voltage applied to the type S. The balancing is done at sound pressure levels somewhat above threshold. The ratio of the voltages at equal loudness is the same as the ratio at threshold for the two earphone types. This has been confirmed experimentally. The threshold information for the type T earphone can then be 'stored' as coupler standard threshold pressures. The whole

procedure is called a 'transfer of threshold' from the type S to type T earphone.

The transfer of threshold can be accomplished also by sound pressure balancing in the ear canals of about ten persons. The voltages on the types S and T earphones which produce the same sound pressure in the ear canal are measured with a probe-tube microphone. The threshold voltages are deduced from these data as in the case of loudness balancing. The advantage of this technique is that greater precision (less variance) is obtainable, since loudness balancing judgments are not needed.

It is clear from the foregoing that the storage and transfer from earphone to earphone of standard threshold information is at present a cumbersome procedure. Research directed toward simplifying and improving audiometric standards is being carried on at the National Bureau of Standards.

The design and construction of a standard earphone has been suggested, since none is available at present. The idea is that the external geometry, particularly the passage from the diaphragm to the ear canal and the cap where it presses against the external ear, would be specified. Also, the acoustical impedance of the diaphragm and the static force of application of the earphone to the ear would be specified. The advantage of such a standard would be the complete elimination of transfer of threshold from one type of earphone to another. If the acoustical impedance looking back into the earphone is properly specified, the previously mentioned change in threshold voltages due to variations in the ear-canal impedances can be practically eliminated. A knowledge of the impedance of the ear-canal, including its statistical distribution, is necessary. Research on measurement of ear-canal impedances is now under way at the National Bureau of Standards.

Another suggestion has been the construction of an artificial ear coupler which would present to an earphone the same acoustical impedance as that of the 'average' ear. Many such couplers have been proposed over the years, but none has been generally accepted as meeting all the needs of a standard for audiometry. However, data from research on impedance of the ear canal mentioned above should provide a rational basis for the design of such a coupler. The advantage of the coupler would be the elimination of loudness balancing (or sound-pressure balancing) for finding the threshold voltages of a new type of earphone. Its voltages would be those which produce the same sound pressures in the coupler as are produced by the standard earphone when threshold voltages are applied.

The desirability of making sound pressure measurements somewhere in the ear canal was mentioned earlier in this paper. Research into such measurements is continuing at the National Bureau of Standards. The measurements are readily made by means of probe tubes which lead to a microphone located outside the earphone-ear combination, as shown in Figure 1. For standardization purposes, it would appear that the probe tube should be located at some anatomically recognizable point in the canal. The tympanic membrane suggests itself immediately, but can be dismissed because of considerable difficulty experienced in making pressure measurements there. The point where the canal passes through the skull

bone (P_e in Figure 1) has been suggested as a suitable place in which the sound pressure should be measured. The National Physical Laboratory in England has suggested that the international primary standard for audiometry might well be the threshold sound pressures at this location. This suggestion suffers from the practical difficulty that it is not easy to locate the point on some persons. The easiest thing to do experimentally is to measure the sound pressure at a point fixed relative to the earphone, for example, in the plane of the edge of the cap (P_e in Figure 1). But the location of this point relative to the entrance to the canal will not only vary from person to person, but will also depend upon the type of earphone.

The variances to be expected in ear-canal measurements must be considered. At low frequencies, below 1000 cps, the only variance arises from the fact that different persons might have different threshold sound pressures in the ear canal. This variance can apparently be measured without difficulty, though it does not appear to have been done in a thorough manner. At high frequencies, the variance from this origin is complicated by the fact that the distance from reference points such as P_c and P_e to the tympanic membrane is a substantial fraction of a wave-length of sound. Hence, wave effects in the canal might cause considerable variations in the threshold sound pressures P_c and P_e for a given pressure at the tympanum.

An important area of audiometry for which there are no standards at all is measurement by bone conduction. The calibration of the vibrators which project sound into the bones of the head requires an artificial head bone, sometimes called an artificial mastoid, whose acoustic impedance matches that of the head. Preliminary measurements of the impedance of the bones of the head have been made at the National Bureau of Standards, as well as at the National Physical Laboratory and the Post Office Research Station in England. Work now under way at the Bureau, in cooperation with the Audiology Center of the Army's Walter Reed Hospital, is aimed at getting impedance measurements on a large number of persons and a measurement of the vibration velocity at threshold for both the forehead and mastoid bones.

Summary. Various methods may be employed to determine sound pressures at the ear. Each of these methods involves a number of technical difficulties which are basic to their application in the specification of audiometric pressures. Common procedures includes coupler, probe tube and loudness balance techniques. A related and complex problem is that of determining standards for the measurement of bone conduction.

Problems of Establishing a Physical Pattern of Audiometry[8]

Many difficulties arise when an attempt is made to prepare a standard for audiometry. The American audiometric zero is now specified in terms

[8]This section is based on the original presentation by J. Donald Harris (Ph.D., Rochester, 1942) who is at the U. S. Naval Medical Research Laboratory at New London, Connecticut. He has developed methods of group audiometry and has tried to find, both experimentally and theoretically, what is the basis of the apparent difference between the American and British Standards. He was invited to evaluate these differences.

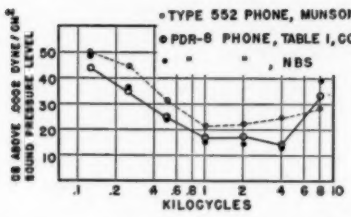

FIGURE 3. Estimates of Ear Canal SPL at American 'Normal.'

of sound pressure level generated in a Type 9A coupler by the Western Electric 705A phone (See Figure 2). Other phones may be used after they have been loudness balanced, using psychophysical techniques and an adequate number of ears for the transfer. No real quarrel can be found with this procedure except that it is time-consuming and may necessitate some reworking of the coupler to accommodate new phone designs.

To avoid these difficulties, numerous workers have recently been reporting threshold data in terms of sound pressure level measured under the earphone, at some point in or near the entrance to the ear canal. If justified, such a procedure could lead to better repetitions of experiments, to a quick probe-tube transfer of loudness from one phone to another and to firmer international agreements on audiometric standards. In this procedure, however, a major assumption is made, namely, that equal sound pressure levels at the entrance to the canal produce equal loudness, irrespective of the type of earphone used. This seemingly very valid assumption was scrutinized at the Naval Medical Research Laboratory by some work done with the old W.E. 552W earphone, the type used with the W.E. 2A audiometer.

In 1940, Munson (quoted by Steinberg and Gardner (*10*)) measured sound pressure level at the ear canal when the earphone voltage of the W.E. 552W was set to 'zero' on the W.E. 2A audiometer. From these data one can pass to ear canal sound pressure level under the 552W at American audiometric zero. This is shown in Figure 3, reproduced from an earlier paper (*8*), together with two sets of direct measurements of ear canal sound pressure level at American audiometric zero under the commonly-used Permoflux PDR-8 earphone in an MX-41/AR cushion. Data from the National Bureau of Standards in Figure 3 were taken from an unpublished research memorandum (*1*).

It can be seen that the data for the 552W indicate that it generates a more intense sound pressure level *at equal loudness* for all but the extreme high frequencies. In trying to understand this, one's first thought is that it is related to the composition of the earphone and cushion combination, the 552W being very hard and the MX-41 cushion of soft sponge rubber. Accordingly, the W.E. 705A, another soft-cushion combination, was substituted for the cushioned PDR-8. Another hard-case model, the British type 4026A, was also substituted. Holes were carefully drilled through the casings and cushions of the three units and identical pieces of plastic tubing inserted and glued firmly so that the end of the tube terminated at the center of the earphone and out about ½ inch from the earphone face. The tubes were 8.8 cm long, o.d. 1.9 mm, i.d. 1.2 mm; the attenuation was well known (*8*).

Six of the staff made loudness matches between the 705A, 552W and 4026A earphones by a binaural alternate loudness balance method. This

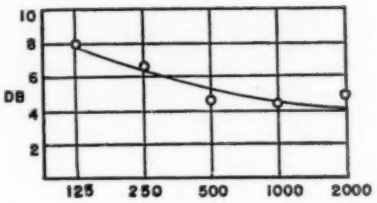

FIGURE 4. Amount by which SPL measured at the entrance to the ear canal under the WE 552W earphone exceeds that measured under the WE 705A earphone at equal loudness.

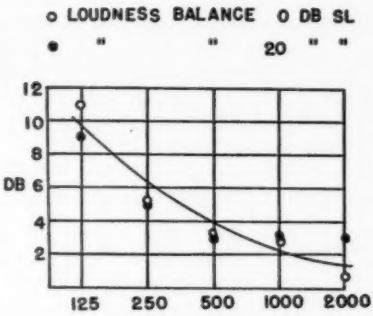

FIGURE 5. Amount by which SPL measured at the entrance to the ear canal under the Standard Telephones and Cables, Ltd., Type 4026A earphone exceeds that measured under the WE 705A earphone at equal loudness.

method is time-consuming but appears to have distinct advantages in reducing variance due to earphone placement, coupling thrust and temporal patterning of stimuli to be judged. Appropriate counterbalancing was built into the experimental design to control for learning, fatigue, order of earphone, *etc*. A holder was designed to take any two earphones and apply them to the pinnae with a thrust of 2000 grams.

Loudness matches were made with a standard voltage to the 705A earphone set to yield 20 db SPL *re* American audiometric zero, at the octaves 125-2000 cps. Higher frequencies were avoided at this time because of the variability introduced by standing waves. After balancing was completed, the voltage to the comparison earphone was noted. Of course, the two ears are averaged in the binaural technique, so that for any frequency a subject yielded only one voltage reading per comparison earphone. However, both the ears were utilized alternately when a particular phone was applied in the standard manner and the sound pressure level at the relevant voltage was read by a probe tube.

The data for the 705A-552W comparison confirm the conjecture that equal loudness under earphones does not always yield equal canal sound pressure level. Figure 4 shows that the 552W generates 4-8 db more sound pressure level. If we now think of this difference as a correction factor, we can apply this in Figure 3 and find an extremely close correspondence between our own and Munson's estimates of canal sound pressure level at American 'Normal.'

The data for the comparison of the 705A with the 4026A earphone are shown in Figure 5. They are similar to those found in Figure 4, except that the difference between earphones are negligible at 2000 cps. The addition of the correction factor here, however, only increases the difference between the values for the two phones. Also in Figure 5 are data showing the difference in ear canal sound pressure level when absolute threshold measurements are used instead of loudness balances. Absolute threshold measurements can be thought of as loudness balancing by

monaural matching at 0 db sensation level. From these data we would predict that on any survey of 'normal' hearing in which both the 4026A and the 705A earphones are used on the same ears, the ear canal sound pressure level would be somewhat greater under the 4026A.

Several explanations have been offered for some or all of these differences. The fit of the earphone to the head is critical, especially at low frequencies where a small leak can necessitate increased earphone voltage to reach equal sound pressure level at any one point. This fit should be better with a soft cushion, as with the 705A. But while it is easy to see that it might be necessary to add an increased voltage to an earphone in order to overcome the loss due to a leak, it is still hard to understand why equal sound pressures at the entrance to the ear canal do not necessarily yield equal loudness.

The 705A differs from the other two earphones not only in fit, but also in the reduced possibility of conduction by routes other than air, either by 'cartilage conduction' from the pinna through to the eardrum, as Barany (2) would suggest, or by some osseous route or routes. The earphones were in firm contact with the head, rendering such a possibility more plausible and they had a tendency to improve bone conduction through a partial occlusion of the canal.

The conduction explanation is considered to be the most satisfactory, but it hardly explains the data at the higher frequencies where attenuation would greatly reduce the bone conduction component. At these frequencies some other factor must be looked for. An unexplained, but perhaps relevant, observation is that when one speaks while wearing a tightly coupled 4026A earphone, one's own voice has a peculiar ringing quality that is not nearly so noticeable with one of the sponge-neoprene earphone cushions.

The data in Figure 5 throw some light on the problems encountered in attempting to standardize audiometry in terms of ear canal sound pressure level. The British (5) recently published data on the threshold sound pressure level in the ear canal under the 4026A earphone. These data at first glance seem to indicate that, up to 25 db, the British ear is more sensitive than the American ear. But one must be careful to make correct comparisons. It is obviously incorrect to compare sound pressure level developed in a closed coupler with sound pressure level measured in the ear canal. Discrepancies in this case, even for the same earphone voltage, may easily reach 15 db at 125 cps. It is also obviously incorrect to compare coupler sound pressure levels that are measured in couplers of different design. Correction factors must be applied if comparisons are to be made in this manner. It now appears that if two earphones are to be compared

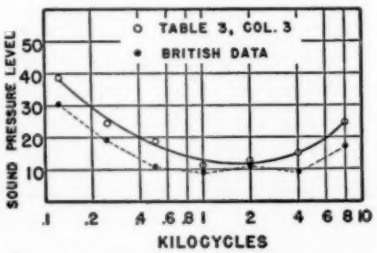

FIGURE 6. Comparison of present data on SPL at threshold in ear canal. The differences may be caused by the equipment used by the investigators.

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by measuring the sound pressure level in the ear canal, a correction factor similar to, or derived similarly to, the data shown in Figure 5 must be applied.

Figure 6, from an earlier study (*8*), shows two laboratory surveys of 'normal hearing,' one using the British 4026A earphones (*5*), the other using a Permoflux PDR-10 earphone in the MX-41/AR cushion.

There are obviously *differences* between the British and American Standards, but it is not known whether they result from dissimilar equipment, from a diversity of methods employed or whether there actually *is* a difference in the aural threshold between the British and American ear.

Summary. The American audiometric zero is now specified in terms of sound pressure levels generated in a Type 9A coupler by the Western Electric 705A phone. The performance of other phones is related to the 705A by means of loudness balance techniques. Pressure measurements show, however, that equal loudness under earphones does not always yield equal canal sound pressures. Various explanations have been offered for these differences. Since the British and American standards involve different techniques, it is not yet known to what extent such effects account for the differences in the two audiometric references.

A Reassessment of the Problem of an International Standard for the Audiometric Reference Zero

Personal opinion enters into the selection of facts from a series of presentations and enters even more strongly into discussion in areas of disagreement or of uncertainty. In composing this article, the reviewer has had the advantage of carefully rereading the full presentations of the Symposium and of a year's time in which to reflect on the problems that were discussed. His personal views may or may not voice a consensus of those who participated.

The central practical question is whether to retain or to modify the present American Standard for Zero Hearing Loss for Audiometric Purposes. The second question concerns how far we should be prepared to modify our present standard in order to agree with an International Standard in case other nations cannot be persuaded to adopt the present American Standard. On these questions there is agreement only that we should suspend judgment until the results of certain experimental studies now in progress are available and have been evaluated. These studies, and perhaps others that will be suggested by them, should resolve the most important doubts that still surround the problems of storing of the standard and of transfer from one type of earphone to another. The reviewer hopes that the practical problems can be resolved sufficiently to allow international agreement on standard equipment and procedure, and on the adoption of standard values, even if the 'missing 6 db' should still prove elusive and equal sound pressure level at the entrance to the ear canal should not always give equal loudness.

On many preliminary or collateral questions there seems to be fairly good agreement. For example, age does elevate the threshold of hearing, statistically speaking, particularly for the higher frequencies and for ages above 30 years. So does habitual exposure to sufficiently loud noise and so do certain otologically recognizable

abnormalities and diseases of the ear. It seems agreed that the standard of normal hearing should be based on the hearing of a group from which the influence of these factors is excluded. There also seems to be agreement that the mode is the proper statistic to employ to express the central tendency. And the necessary specifications for the acoustic environment of threshold tests are now unanimously accepted.

The clarification of the methods of selection, the conditions and the physical methods of measurement employed in the USPHS audiometric survey should remove the doubts that some have held on these points. It now seems clear that another basis must be found to explain the differences of auditory sensitivity found between this survey and the British tests and numerous American studies made under 'laboratory conditions.'

Surprisingly, no one raised the question of the exact form of the acoustic stimulus or the psychophysical method, although in 1936 a slower rise time for the signal was in vogue than at present. Apparently there is tacit agreement that the current use of 'beeps,' or brief tone bursts, does not significantly lower the ultimate threshold, even though it may expedite the procedure and require less effort from the listener. It will be helpful if no new or separate standard is required for tone bursts, as they are employed in most forms of automatic audiometry.

A general conviction developed during the symposium: that the central problem (the basis of the difference between the present American and British standards) does not lie in the selection of subjects, in the nationality of the subjects, in the physical equipment employed, in the psychophysical methods used or in the later statistical analyses; the problem probably lies only in small part in differences in the way the information is 'stored' and transferred in headphones, couplers and pressure measurements. The difference seems to lie chiefly in the way in which the subjects are handled and the attitude of operators and subjects toward the measurement of auditory thresholds. The difference of attitude was best summarized by the phrases 'clinical threshold' and 'survey type of standard' on the one hand and 'laboratory ear' or 'laboratory standard' on the other. (This opinion is now supported by the analysis of data from the second as well as from the first Wisconsin State Fair study, recently published by Glorig and his associates (*6*).)

The 'laboratory standard' seems to be reliable. It has been reproduced a number of times on both sides of the ocean. It is consistent with the equal loudness contours, which are basic for the psychologist and for the acoustical engineer. The 'survey' or 'clinical standard' seems to be valid to the extent that it has the tacit approval of American otologists and audiologists. The latter seem to be satisfied that the American Standard for zero hearing loss means what they want it to mean: the commonest value for the threshold of hearing, measured under clinical conditions in audiometrically naive young adults in good health and with 'presumably normal' hearing. It is not known whether this 'clinical standard' is as reliable as the 'laboratory standard.' Perhaps the final analysis of the Wisconsin State Fair data will settle this question.

The American clinical standard has been established in this country for many years and the literature of

American audiology is based on it. There will probably be considerable resistance from otologists and audiologists to a change to a new 'laboratory type' standard, at least if the proposed change is more than 5 db for the central speech frequencies. It will be necessary to convince them that the long run benefits of a standardization that is international and interdisciplinary will outweigh the inconvenience and the mental effort that will be needed in the years of transition. In the meantime, as long as there are two standards there will be confusion and a necessity for two names and two abbreviations.

Within the next year, experimental results may establish the correctness of the assessment of the situation. If the assessment is confirmed, American professional people must choose. Shall the American Standard be 'the commonest value for the threshold of hearing measured under clinical conditions . . . ' (Beasley) or shall it be one 'which expresses the state of hearing . . . ' (Dickson), with the implication that the measurement is made under completely favorable circumstances and with favorable set and good motivation? The reviewer personally favors an international standard based on the British, rather than the USPHS approach.

The reviewer also offers a final practical suggestion. Whether or not a change is made in the American Standard, it will be very helpful to introduce a new term to avoid the present confusion associated with the term 'hearing loss.' The new term should avoid the misleading term 'loss.' It should express the idea of status relative to an accepted standard. Then the clinician can frame his concepts of 'range of normal,' 'threshold of social adequacy of hearing,' *etc.*, on a scale that is purely descriptive and is not semantically loaded like the concept of 'hearing loss.'

Very recently (in the preparation of the final report of CHABA Working Group No. 25), just such difficulties were encountered with the multiple meanings of the term 'hearing loss.' In the medico-legal context it is very important to distinguish between the objectively measured threshold of hearing, as given by the reading on an audiometer dial and the implication of a 'loss' or impairment of hearing. Readings up to 10 db of 'hearing loss' are within the range of normal threshold values and do not necessarily imply that the subject's threshold is any higher than it ever was. Furthermore, an additional change of threshold in the direction of reduced sensitivity is now also called a 'hearing loss,' even though, for a given individual, the change may not have started from the audiometric zero.

To clarify this confusion Rosenblith, Glorig and Davis, writing for Working Group No. 25, are using a new term to designate a deviation from the American Standard for audiometric zero. This term is 'hearing threshold level' or, more briefly, 'hearing level.' This will designate objectively the *reading in decibels* on the audiometer. For a *change in the status* of hearing of an individual, the term 'threshold shift' will be employed.

The reviewer believes that the terms 'hearing level' and 'threshold shift' could be adopted universally to great advantage. The term 'hearing loss' would be retained to designate the symptom of diminished sensitivity of hearing, just as the otologist now uses it in the phrase 'conductive hearing loss,' with its suggestion of an *ab-*

normal condition. The new term 'hearing level' would mean simply the deviation from an arbitrary reference level, with no built-in implication of abnormality. Positive numbers of decibels would mean elevation of an individual's threshold of hearing above the threshold reference level.

'Hearing level' would be closely related to the present 'sensation level.' The latter term would presumably be retained to indicate the number of decibels above the *individual's own* threshold level, whereas 'hearing level' would be referred to a general arbitrary zero reference level. If the latter is the American Standard Level, the abbreviation would be 'x db AHL' (American Hearing Level). If the British level is used, it would be BHL and if an International Standard is adopted, we would write IHL for an audiometric reading that is referred to an International Hearing Level.

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Children As Guides To Teaching

Jane E. Beasley

Speech therapists engaged in clinical practice are continually searching for more effective teaching methods. Regardless of their theoretical background or of the assistance received in their early supervised training, the day-by-day demands of working with children and young people call for considerable ingenuity. New ideas are scrutinized to see if these will capture the attention of younger children or be meaningful and interesting to older ones. Activities are devised that will involve children sufficiently for them to be willing to change unacceptable speech patterns in order to participate.

This justifiable interest in practical procedures has certain consequences. On the one hand, it frequently leads to some worth-while discoveries that simplify planning: it may provide a fresh approach to working with a difficult class, or it may arm the inexperienced teacher with something to do. These advantages are not to be discounted. On the other hand, it seems possible that the very elaboration of a new game, contest, drill, or attempt to recreate a life situation in which speech can be practiced may serve to deflect thinking from the children themselves. In structuring the child's participation in a particular learning assignment thought to be beneficial to his speech, other aspects of his development may be overlooked. If the child does reveal something of his own enthusiasm or rebellion, the therapist's concern with speech frequently requires that she redirect his energies toward the task at hand instead of attempting to understand his behavior and deal with it. In such circumstances, teaching methods or motivational devices can become a barrier to learning instead of a facilitating agent.

In this article, two hypotheses are discussed: (1) that a child supplies his own suggestions for motivated learning if there is attention to what he spontaneously says, does and feels; and (2) that attention to the child's behavior permits greater range for helping him with developmental processes, of which speech is only one part.

Self-direction. A child-centered orientation is by no means new to education. Adherence to a child's needs and interests as he reveals them in his conversation, play, and in the level of his speech performance, furnishes useful clues to be used against the backdrop of prescribed content. It is generally accepted in instructional circles today

Jane E. Beasley (Ed.D., Teachers College, Columbia University, 1955) is Assistant Professor of Education, Rutgers University. This article is adapted from a paper presented at the 1956 convention of the American Speech and Hearing Association in Chicago.

that every child is an active, purposive individual with goals and motives of his own. The impulse for growth resides within him and cannot be forced or hurried from without. Real change has to be nurtured rather than maneuvered. This suggests that the elements most suitable to each child's learning cannot always be predetermined, particularly when, as is true for children with speech difficulties, there has already been a learning failure somewhere in his developmental history. The steps in speech reeducation are not easy to define logically and systematically in advance. Instead, the pattern of change assumes its own individual characteristics as growth continues. Assistance must begin where the child actually is, not where it is believed he ought to be, and then be integrated with the leads he himself gives as he progresses. Cantor (*1*) states: 'All genuine learning in the final analysis is self-education.' To set this process in motion requires as much attention to the child and his impetus for and resistance to change, as to the therapeutic techniques employed.

Self-enhancement. It is also generally accepted that a child learns (in a meaningful way) only those things which he sees as maintaining or increasing his self-respect or security. Oftentimes a child's sense of satisfaction is largely dependent on teacher praise. Of more lasting benefit, perhaps, is the *child's* recognition of his abilities. The feeling that he is 'all right' is essential if he is to continue to improve. Snygg and Combs (*3*) hold that 'activities and techniques which result in success and an increased feeling of self-esteem will be repeated; activities which result in failure or humiliation are avoided.' Skillful teaching which brings about learning must reflect not only the child's own urges to explore and extend his horizons, but it must also contribute to and sustain his feelings of worth about himself.

Barriers to Learning. Provisions are not easily made for self-direction and self-enhancement in speech defective children. Some of the hazards may be intrinsic to the nature of the therapy process itself. What happens, for example, to a child's speech spontaneity while he is receiving help? Instruction is usually begun with a negative evaluation of the way the child talks and an attempt to help him differentiate between acceptable and unacceptable elements in his own speech and that of others. It is then followed by a rigorous structuring of what he is to say, how he is to say it, and repeated experience or practice. Early in the re-education sequence he has to rely on the direction of others to a large extent. It is expected in the ordinary course of events that he will incorporate suggestions and gradually become able to regulate his own speech. Sometimes, unfortunately, this does not happen and the child continues to need reminders. In either case, since speech is an expression of a child's independence and initiative, care must be taken that these qualities are not jeopardized when he is being assisted to modify his way of talking.

What happens, on the other hand, to his feelings of acceptability during speech therapy? Corrective treatment can sometimes be very threatening. Such effects on the child are rationalized by assuming that while he may feel less secure about himself when he is changing his speech, he will become a more comfortable and effective person once his speech improves. This is probably true for many children. For others, however, it seems debatable.

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A young child, or any person for that matter, finds it almost impossible to differentiate emotionally between a shortcoming in a skill area and a pervasive feeling of personal inferiority. The feeling may persist long after the skill has ceased to be a problem. Repeated efforts to help a child make the fine muscular adjustment necessary to alter phonetic characteristics of certain sounds may serve to diminish instead of increase confidence. Communication, at best, is fraught with distortions and barriers, many of which have their origins in the prohibitions placed on all young children. When a child has to have aid in talking differently, the goal of appropriate articulation for him must not be achieved at the cost of a favorable self-concept.

In essence, then, the barriers to learning in speech therapy constitute a two-horned dilemma. On the one hand, disordered speech clearly interferes with effective functioning and requires attention. On the other hand, steps in the therapeutic process, if not sensitively handled, may easily upset or injure the child's development of ego strength. The problem then becomes one of seeing what modifications can be made in teaching which will ally it more closely with the child and be less likely to produce undesirable side-effects. This suggests that the therapist, in order to assist children to learn, needs first to give herself time with children in order to discover more about their world, time when she is not compelled to direct, channel, or umpire an activity, and time when she is available to participate rather than manipulate. Such an approach also suggests that the therapist be familiar with the maturational stages in the growth of children - - - not only the characteristics of language development, but also the conflicting emotional drives which children have to work through at each age level.

In the paragraphs that follow, the developmental tasks of three age groups will be described with some of their implications for speech therapy.

Three-to-Five-Year-Olds. The child from three to five years of age must learn many forms of control in eating, dressing, toileting, rudiments of cooperative play, and self-assertiveness. Because of the amount of prohibition with which he is surrounded, he must also learn to cope with his destructive impulses and with his rage against such limitations. During this period, if clinical help in speech seems indicated, there should probably be a minimum of control and much encouragement of the child's exploration and experimentation, as in the situation described below.

A small group of children with fragmentary language came to a university clinic two hours a day. Materials were limited to blocks, dolls, some playhouse equipment, sand, and clay. One boy climbed into the doll bed each day, closed his eyes, and pulled the cover over himself. Every day the teacher said: 'Night-night, Bobby.' Eventually he repeated this. Later he put a doll in the bed and talked to it, using the same expression. Marjorie, who made few overtures to anyone, one day began tentatively to hand small pieces of clay to the teacher, and then to reach out for them to be returned. The teacher used the words 'yours' and 'mine' with her, pacing the words in accordance with the child's action. The following day the little girl resumed the activity, accompanying it by 'Give it you' and 'Give it me.' This phrase she later

used in other experiences when she became able to exchange toys with other children. Both children were free to move about and play as they chose. Instruction was only informally given, and then always in conjunction with what the children were already doing. Phonetic revision of their fragmentary language was not attempted until much later.

Six-to-Eight-Year-Olds. During the period from six to eight years of age, the child is learning industry, acquiring what Erikson (2) calls the tools and skills of the work world. Erikson further suggests that the child is almost certain to be confronted with feelings of inferiority if he cannot or does not meet acceptable standards of performance. It would seem that any speech therapy for a youngster during this time should take into account the multiple pressures under which he is functioning. As in the following example, care should be taken not to increase pressures unduly and not to reinforce inferiority feelings which can so easily pervade the child's self-concept for the remainder of his life.

Three boys between the ages of six and eight came twice a week to a speech clinic after school. They were given a part of the hour to do as they liked. Sometimes they erected a big fort and carried on a noisy battle. Sometimes they played a quiet card game, or had a tic-tac-toe contest, or played hide-and-seek. Midway in the hour the therapist stopped the activities and reviewed the childrens' utterances. She selected phrases with which they needed help, such as 'Keep away' for 'Teep away,' and 'It's your turn' for 'It your turn.' The boys either resumed their play and checked themselves on one or two phrases, or stopped play entirely and worked more intensively on speech elements for the rest of the period. In this situation, consideration was given to minimizing restrictions, to avoidance of undue emphasis on shortcomings, and to utilization of the boys' own inventiveness for work on speech.

Nine-to-Eleven-Year-Olds. The child who is between nine and eleven years old is acquiring more independence, beginning to rebel against authority, and forming solidarity with his age group. During this time he does not need to be reminded of who is 'boss' as often as he needs positive support for his newly developed endeavors. It is not always possible for a teacher to be aware at the time of the possibilities for learning contained in a fad or craze that can sweep a class. Sometimes, however, these can become the center of many new discoveries for both children and teacher, as in the following instance.

In a clinic session which the children attended daily, one boy discovered during recess a supply of crickets in an abandoned tar-paper pile near the speech building. He went into business, catching the insects to sell for fishing bait in his neighborhood and sub-contracting with the other boys to work for him. This became such a successful business venture that speech goals became quite secondary for the entire group. Only later did the teacher realize how this self-selected, highly motivated experience might have been converted into practice on the sounds contained in counting, making change, price lists, keeping records, *etc.* Team organizations, collecting and trading, jokes and riddles, 'top-this' stories, and compliments are examples of self-motivated pursuits that lend themselves to speech correction, too.

Conclusions

A child-centered orientation to speech therapy with attention to the broad developmental processes of children poses some difficult issues. Such an approach, it may be argued, wastes time when work should be going on. Parents or school systems are paying for instruction, not play. The speech therapist is responsible primarily for the child's speech, not his peripheral learnings. The space and equipment needed in such practices are somewhat different from what is usual in a speech program, and occasionally very impractical. It can also be argued that there is little research evidence as yet to indicate that implementation of such an approach brings about changes in speech as effectively as the more traditional methods.

In spite of these persuasive arguments, it seems reasonable to assume that the fact that children solve successive developmental problems leading to self-realization through their own initiated work and play experiences has relevance for speech therapy. When teachers are free to tap the leads children themselves provide, and are resourceful in supplementing and extending such leads, children can serve as their own guides to meaningful correction.

Summary

The essential hypotheses of this discussion are (1) that a child supplies his own suggestions for motivated learning if there is attention to what he spontaneously says, does and feels; and (2) that attention to the child's behavior permits greater range for helping him with developmental processes, of which speech is only one part. Certain of the problems are discussed which are associated with a child-centered orientation to speech therapy with attention to the broad developmental processes of children.

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Suggestions For Terms Applied To Electrophysiologic Tests Of Hearing

Robert Goldstein

A. J. Derbyshire

A diversity of terms and abbreviations have been applied to the electrophysiologic techniques used in the testing of hearing. We are advancing a set of terms that appear to us to be more appropriate than those commonly used in audiologic literature.

Two kinds of electrophysiologic phenomena are being used more and more frequently in clinical audiometry: (1) the electric properties of the skin as manifested either by the impedance to flow of direct or alternating current, or by the differences in electric potential between two points on the skin; and (2) the electric activity of the brain, as detected by electrodes attached to the scalp. Less frequently employed are such phenomena as the electric activity of the muscles and the heart, respiration, and changes in the volume of a finger or toe. Records of all these latter activities, as well as the electric activity of the brain, have a set of names and abbreviations which have a common form (see Table 1).

In order to be consistent with the conventional designations for the recording of various physiologic phenomena, and also to include the variety of ways in which the phenomena can be recorded, we suggest that the terms in Table 2 be used in clinical audiometry.

What we wish to call EDR Audiometry is presently more commonly called GSR Audiometry. Our main criticisms of the term Galvanic Skin Response (or Resistance or Reflex) are: (1) it does not clearly include changes in potential as well as in resistance, nor does it include changes in the complex impedance of the skin to the passage of alternating current; and (2) it does not contain descriptive words that are analogous to the words used in describing other electrophysiologic phenomena.

One may argue that, in spite of its shortcomings, the term Galvanic Skin Response is in rather common use and should be retained to prevent confusion. We wish to point out, however, that a variety of terms have been used to designate this same phenomenon. The following is a list of some of the terms and abbreviations

Robert Goldstein (Ph.D., Washington University, 1952) is Research Associate, Central Institute for the Deaf, and Assistant Professor of Audiology, Washington University, St. Louis, Missouri; A. J. Derbyshire (Ph.D., Harvard University, 1935) is Director of the EEG Department, Harper Hospital, and Chairman of Research Planning Team at Michigan Epilepsy Center, Detroit, Michigan.

TABLE 1. Designation of the recording of various physiologic activities.

Activity	*Recording*	*Abbreviation*
Electric		
Brain-activity	Electroencephalogram	EEG
Muscle-activity	Electromyogram	EMG
Heart-activity	Electrocardiogram	EKG
Respiration	Pneumogram	PNG
Volume-changes	Plethysmogram	PLG

TABLE 2. Suggested terms for use in clinical audiometry. (Similar terms can be constructed when electrocardiograms, electromyograms, pneumograms, or plethysmograms are used for audiometric purposes, *e. g.*, EKR-Audio, *etc.*)

Recording, Response, or Test	*Term*	*Abbreviation*
Recording of the electric impedance or the electric potential of the skin.	Electrodermogram	EDG
Significant changes in the electric impedance or potential of the skin following stimulation.	Electrodermal Response*	EDR
Tests of 'hearing' which utilize electrodermal responses as indicators of reaction of the ear and central nervous system to sound.	Electrodermal Audiometry	EDR–Audio
Recording of the electric activity of the brain from electrodes on the scalp.	Electroencephalogram	EEG
Significant changes in the pattern of electric activity of the brain following stimulation.	Electroencephalic Response	EER
Tests of 'hearing' which utilize electroencephalic responses as indicators of reaction of the ear and central nervous system to sound.	Electroencephalic Audiometry	EER–Audio

*First introduced by Ruckmick and his colleagues (*1, 2, 3, 4*).

that have been used in the physiologic, psychologic and audiologic literature since 1950: Psychogalvanic Skin Resistance (PGSR), Psychogalvanic Skin Response (PGSR) Psychogalvanic Skin Reflex (PGSR), Psycho-galvanic Response (PGR), Galvanic Skin Resistance (GSR), Skin-Galvanic Test, Electroaudiogram (EAG), Electrodermal Response (EDR), Psychogalvanic Reflex (PGR), Galvanic Skin Reflex (GSR), Galvanic Skin Response (GSR), Réflexe Electrodermale (RED), and Réflexe Psychiatre.

We believe that our suggestions provide a more inclusive term for the electric phenomena of the skin and greater uniformity in description of the various electrophysiologic phenomena.

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Four Psychological Scaling Methods Applied To Articulation Defectiveness

Dorothy Sherman

Catherine E. Moodie

The purpose of the present study was to compare several psychological scaling methods with respect to their usefulness for scaling defectiveness of articulation of short segments from the continuous speech of children. The methods selected for evaluation were equal-appearing intervals, successive intervals, pair comparisons and constant sums.

Selection of Scaling Methods

1. The method of equal-appearing intervals was included because of its common use in experimentation with speech disorders. In the application of this method the observer is instructed to assign numbers to the stimuli in relation to an equal-appearing intervals scale of severity.

2. The more elaborate computational procedure of the method of successive intervals, which can be applied to equal-appearing intervals data, was also selected. This method is aimed at reducing the end effect, that is, the effect from a piling of judgments in the end intervals. For the method of successive intervals, the assumption is made that the responses to the segments would be normally distributed if it were not for the terminal points of the scale. The data are normalized and then the relative width of each interval along the scale is estimated. These estimates serve as reference points in deriving scale values. A check of internal consistency is also provided.

3. The method of pair comparisons was included because it is usually thought to be the psychological scaling procedure which will give the most dependable and useful results. Ordinarily, all stimuli to be evaluated are presented to the observer in all possible pairs. The observer is asked to make a comparative judgment for each pair by indicating which member of the pair seems greater with respect to some defined characteristic. In theory, observer biases, which apparently influence results obtained by interval scaling procedures, are eliminated by requiring the observer to make a discriminal reaction to each possible pair of stimuli. The method of pair comparisons also provides for a test of internal consistency.

4. The method of constant sums was selected since it is designed to obtain values in terms of ratios and, thus, to result in a ratio scale instead of an interval scale. Ratio scales have

Dorothy Sherman (Ph.D., Iowa, 1951) is Associate Professor of Speech Pathology and Audiology and Catherine E. Moodie (M.A., Iowa, 1957) is Instructor (half-time) of Speech Pathology and Audiology, State University of Iowa.

certain advantages over interval scales. They have absolute zeros; ratios of numbers on the scale can be used in all number and statistical operations and the results can be meaningfully interpreted. By this method the observer judges by reporting, in effect, his estimate of the ratio between two stimuli with reference to the characteristic to be scaled; usually, he estimates this ratio by dividing 100 points between the two members of the pair. Obviously, the required judgment is not a simple one, and the applicability of the method for the purpose of scaling speech defectiveness is open to question.

Procedure

Test Items for Scaling. Experimental material used for the four methods of scaling articulation defectiveness consisted of five-second segments from the continuous speech of children between the ages of five and ten years selected from the experimental material employed in an investigation by Morrison (5). In the earlier experiment 60 five-second segments, one from the continuous speech of each of 60 children, were scaled on a nine-point equal-appearing intervals scale. To construct severity scales, four sets of nine segments each, with one segment at each of nine levels of severity (36 in all) were selected from the 60 segments. For the purposes of the present experiment, 27 of the 36 segments were selected with scale values distributed as evenly as possible between .50 and 8.50. They represented a range of articulation from normal to severely defective.

Equipment. High fidelity equipment was used for recording of speech samples and for playback. Tape speed was 15 inches per second. All listening sessions took place in a sound-treated room.

Observers. Three major groups of observers, 350 in all, judged the speech segments. The observers were undergraduate students currently enrolled in an elementary psychology course. Two groups of 125 observers each were employed for the methods of pair comparisons and constant sums. The remaining 100 judged by the method of equal-appearing intervals. The equal-appearing intervals data were used to compute scale values both for the method of equal-appearing intervals and for the method of successive intervals. Not more than 20 observers participated in any one listening session; this provision was made for the purpose of insuring control of the listening procedure.

Listening Procedure for Methods of Equal-Appearing Intervals and Successive Intervals. In the listening session for the methods of equal-appearing intervals and successive intervals, 12 five-second practice segments preceded the 27 experimental segments. These 12 segments were selected from the original experimental material to represent a range of articulation from normal to severely defective and the order of presentation was randomized with respect to severity of defectiveness. During the instructions speech samples representing the extreme ends of the scale were presented. The observers first listened to the 12 practice segments without making judgments. They then judged the entire 39 segments unaware of the fact that the first 12 were practice ratings. The order of presentation of the 27 experimental segments was also randomized with respect to severity of articulation defectiveness. Each segment

was preceded by an announcement of the segment number and followed by a three-second interval to allow time for the observers to record their judgments.

A nine-point scale, extending from *one*, for least severe, to *nine*, for most severe, was employed. The observer was told that he could not place segments between any two of the nine points, but only at these points.

The response sheets were collected and the observers were asked to rate the 27 experimental segments again. The order of presentation of the segments remained constant. Again the response sheets were collected and the experiment was repeated. The session required approximately one hour.

Listening Procedure for Method of Pair Comparisons. In the listening procedure for the method of pair comparisons, the 27 five-second segments were presented to the observers in pairs. Rather than pairing each segment with every other segment, a modified procedure was used. The 27 segments were numbered in order from least to most severe according to the scale values obtained by Morrison (*5*). Each segment from Number 1 through Number 9 was paired with every other segment in this group. Segments Number 7 through Number 15, Number 13 through Number 21, and Number 19 through Number 27 were paired in the same manner. This procedure resulted in a total of 144 pairs of segments. Order of presentation of first or second within a pair was alternated for each sample. No segment was presented in two successive pairs. Each pair was preceded by the announcement of the pair number. A one-second interval separated the two segments in each pair, and a three-second interval followed each pair to allow time for making and recording the judgment.

Twelve practice pairs were provided for the observers. These 12 pairs were composed of randomly arranged pairs from the practice segments used in the interval scaling. The same procedure was used to record these practice pairs as was employed with the experimental pairs, including announcement of pair numbers and intervals for judging. The observers were informed that these 12 pairs were for their own practice.

The observer was instructed to listen to each pair of segments and to indicate which of the two, the first or the second, seemed more severely defective in articulation by writing *1* or *2* in the appropriate space on the response sheet. Two pairs were used during the instruction period to illustrate how to record the number of the segment which seemed more defective in articulation. The session required approximately one and one-half hours, including a ten-minute rest period after the first half of the pairs had been judged.

Listening Procedure for Method of Constant Sums. The method of constant sums involved making judgments in relation to pairs of segments just as the method of pair comparison did. However, the observer, instead of being instructed to make a simple comparative judgment, was asked to evaluate the relative degree of defectiveness displayed by the members of each pair. He was told to do this by dividing the constant sum of 100 between the two. Thus, if the two segments within a pair seemed equally defective in articulation, 50 points were to be assigned to the first and 50 points to the second. If one segment of a pair seemed more severely defec-

tive than the other, a relatively larger number of points was to be assigned to the more severely defective segment. Two pairs of segments were played during the instruction period for illustrative purposes. The observer was instructed to record his judgments on the response sheet in the two squares provided for each pair. The points for the first segment were recorded in the left-hand square and those for the second segment in the right-hand square.

The pairings were the same for the method of constant sums and the method of pair comparisons. The only important difference between the two presentations of the segments was that it was necessary to allow an interval of six seconds following each pair in the constant sums procedure for the observers to make and record their judgments. The same 12 practice pairs preceded the experiment and each pair was introduced with the announcement of the pair number.

Computational and Evaluative Procedures. For the method of equal-appearing intervals, median scale values and *Q*-values were obtained from the judgments in the manner described by Thurstone and Chave (*6*).

The procedure outlined by Attneave (*1*) was used to compute scale values for the method of successive intervals. The procedure of Edwards and Thurstone (*3*) for computing a table of theoretical proportions in each interval was employed to check internal consistency.

Thurstone's Case V procedure (*4*) was used to obtain scale values for the method of pair comparisons. The Mosteller chi-square test (*4*) was applied to study the internal consistency of the pair comparison scale values.

A procedure recommended and described by Baker and Dudek (*2*) was employed to compute scale values for the method of constant sums. The first step was to obtain the total number of points assigned to each stimulus. The total number of points for each stimulus was then divided by the total for the smallest stimulus instead of by sucessive totals. This particular procedure was used to avoid cumulative multiplication and still maintain the smallest stimulus as the defined unit of the scale.

Sets of scale values were studied by means of graphical comparisons. In some cases the relationships were found to be linear and, in others, curvilinear. When linearity prevailed, Pearson *r*'s were computed and regression equations obtained.

Evaluation of Scaling Methods

The scale values for the 27 experimental segments computed from the

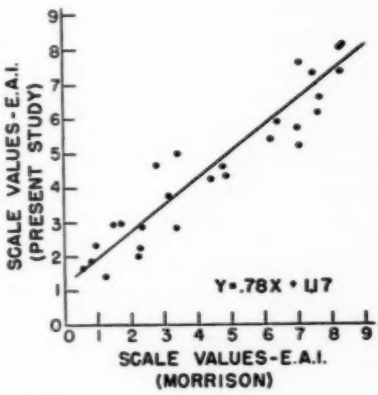

FIGURE 1. Scale values obtained by the method of equal-appearing intervals (E.A.I.) in this study plotted against the corresponding scale values obtained by the same method by Morrison.

first set of judgments by the method of equal-appearing intervals were plotted against the corresponding values obtained by Morrison. Figure 1 shows the plot of these two sets of scale values as well as the linear regression line. This regression line, the equation for which is $Y = .78X + 1.17$, demonstrates the primary difference between the two sets of values. The range of the scale values obtained from the data of the present experiment is comparatively restricted at both ends of the scale, especially at the low end. Deviations from the regression line can also be seen in the plot. Only four of the deviations are as large as or larger than 1.00. The average deviation is .58. Possibly these differences and the constriction of the scale resulted from the changed order and sequence of presentation when only 27 of the originally scaled 60 segments were judged. The correlation (.95) between the two sets of scale values, however, is high. Thus, in spite of the above-noted differences, the assumption that the procedure yields satisfactorily reliable scale values seems justified.

Further evidence of reliability is provided by comparisons of the three sets of scale values obtained from the judgments made on three presentations of the 27 segments in the present experiment. When the values obtained from the data from one presentation are plotted against those from any other presentation, in each instance all plotted points fall extremely close to the linear regression line. For this reason the plots are not reproduced here. For all three comparisons the correlation coefficient is .99. The method of equal-appearing intervals can thus be used with confidence as far as reliability is concerned.

All references made later to the scale values obtained by the method of equal-appearing intervals will refer to the first of the three sets of scale values obtained by this method in the present study.

Scale values were computed by the method of successive intervals from a table of cumulative proportions yielded by the method of equal-appearing intervals. Cumulative theoretical proportions of judgments in the nine intervals for each of the 27 segments were obtained and compared with the corresponding observed cumulative proportions to evaluate the internal consistency of the successive intervals scale values. The agreement between the observed and theoretical proportions is very close. Only 11 of the 216 theoretical proportions which are free to vary show deviations from the observed proportions which exceed .05. The mean deviation of these 216 proportions is only .019. This close agreement indicates that

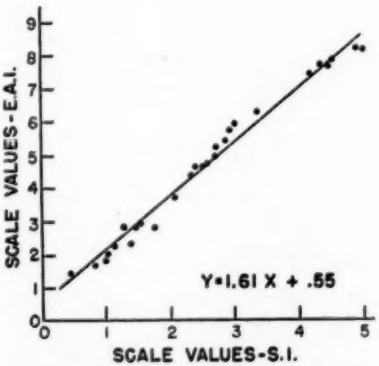

FIGURE 2. Scale values obtained by the method of equal-appearing intervals (E.A.I.) plotted against the corresponding scale values obtained by the method of successive intervals (S.I.).

the successive intervals scale is internally consistent.

The scale values obtained by the method of successive intervals were plotted against the scale values computed by the method of equal-appearing intervals. The plot, shown in Figure 2, along with an obtained correlation coefficient of .99, indicates very close agreement between the two sets of scale values. Only two of the deviations from the linear regression line, as seen in the plot, exceed .50, and the average deviation from the linear regression line is only .23. Thus, in view of the demonstrated internal consistency of the successive intervals scale and the close agreement between the scale values derived for the methods of successive intervals and equal-appearing intervals, the use of either method for scaling defectiveness of articulation seems warranted. However, the method of equal-appearing intervals seems much more practicable when the labor involved in computation is considered.

In scaling other types of speech disorders, the more elaborate method of successive intervals may be warranted. However, it seems likely that a comparison of sets of scale values obtained from the same data on such speech disorders as voice quality or stuttering by the method of successive intervals and by the method of equal-appearing intervals would result in agreement as close as that which was found in this study.

Figure 3 shows the scale values obtained by the method of pair comparisons plotted against the values obtained by the method of equal-appearing intervals. Examination of the plot makes readily apparent the linear relationship between the two sets of values. The average deviation from the regression line is only .46. The correlation coefficient of .96 indicates a close relationship between the two sets of scale values. If the particular scale values obtained in this experiment by the method of pair comparisons are evaluated by comparison with the values obtained by the method of equal-appearing intervals, they must be accepted as satisfactory. However, the four Mosteller chi-square tests of internal consistency[1] of the scale values obtained by the method of pair comparisons were all highly significant. The method of pair comparisons with computation of scale values by Case V is thus not, in general, to be considered satisfactory for scaling speech samples such as those employed in this experiment.

The lack of internal consistency may have resulted from inequality of discriminal dispersion. In this case an

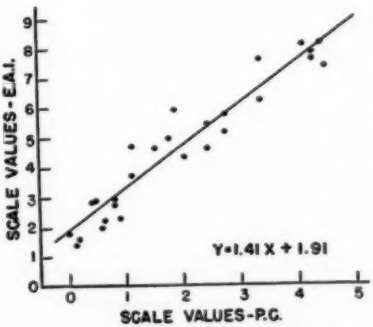

FIGURE 3. Scale values obtained by the method of equal-appearing intervals (E.A.I.) plotted against the corresponding scale values obtained by the method of pair comparisons (P.C.).

[1]The chi-squares obtained for the four groups of segments were 148.47, 107.40, 165.08, and 192.65. A chi-square of 48.28 ($df = 28$) is required for significance at the 1% level of confidence.

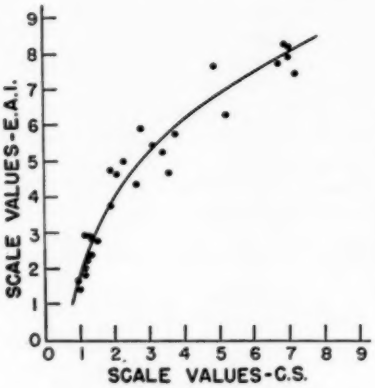

FIGURE 4. Scale values obtained by the method of equal-appearing intervals (E.A.I.) plotted against the corresponding scale values obtained by the method of constant sums (C.S.)

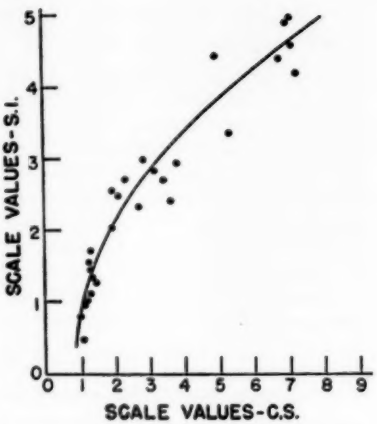

FIGURE 5. Scale values obtained by the method of successive intervals (S.I.) plotted against the corresponding scale values obtained by the method of constant sums (C.S.).

appropriate solution can be accomplished under the assumptions of Case III (*4*). The computational procedures, however, are even more laborious than those for Case V. The additional time and labor which would be required in the present instance did not seem justified.

In view of the demonstrated reliability of scale values obtained by the method of equal-appearing intervals and their close agreement with the internally consistent scale values obtained by the method of successive intervals, the method of equal-appearing intervals would, in general, be the preferred choice for the task of scaling short segments of speech with respect to articulation defectiveness. The simplicity of the method, including computational procedures, makes possible the scaling of many more speech segments with a reasonable amount of time and labor than either of the other two methods, particularly the method of pair comparisons.

The distribution of scale values obtained by the method of constant sums appears to be very different from those obtained by the other three methods. Figures 4, 5 and 6 show the scale values obtained by the method of constant sums plotted against those obtained by the other three psychological scaling methods, respectively. The smooth curves were drawn by inspection. The curvilinearity of each of these plots would indicate that something different was operating in the measurement by the method of constant sums. Figures 4 and 5, where the constant sums scale values are plotted against the scale values of equal-appearing intervals and successive intervals respectively, are highly similar. In each instance the trend line is definitely curvilinear with small deviations from the line at the

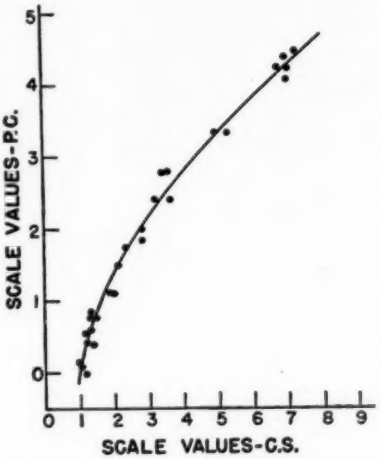

FIGURE 6. Scale values obtained by the method of pair comparisons (P.C.) plotted against the corresponding scale values obtained by the method of constant sums (C.S.).

lower end of the scale and larger deviations from the line through the middle and upper end. The similarity of these two plots is to be expected because of the high correlation between the equal-appearing intervals and successive intervals scale values.

Figure 6, which shows the constant sums scale values plotted against the pair comparisons scale values, also illustrates a curvilinear relationship. The points, however, fall much closer to the trend line, and the function, although curvilinear, appears to depart less markedly from linearity. A possible explanation might be that the judgments were made in response to the same pairings of segments. The curvilinearity, however, is to be expected because of the high correlation between the scale values obtained by the methods of pair comparisons and equal-appearing intervals.

As may be seen in any one of the plots, the constant sums scale values cluster at the extremes of the scale with large gaps through the middle of the range. Possibly the method of constant sums requires the listener to make too fine a discrimination between speech samples, or the large gaps may have resulted from the computational procedure involved. The multiplication of ratios to find scale values may cause overestimation of the values in the middle and upper end of the scale. The use of the segmented system of pairing employed in this study may also be open to question. However, it is obvious that the pairing of each segment with every other segment places serious restrictions on the number of samples which can be scaled. In terms of the unequal dispersion of scale values and the demonstrations of non-linearity, the values obtained for the method of constant sums in the scaling of articulation defectiveness appear to be the least useful of the four sets of scale values.

Summary

The purpose of this study was to evaluate and to compare the usefulness of several psychological scaling methods applied to short segments of the continuous speech of children with defective articulation. The four psychological scaling methods used were equal-appearing intervals, successive intervals, pair comparisons, and constant sums. Test items for scaling were high fidelity tape-recordings, five seconds in length, of the continuous speech of children between the ages of five and ten years. The segments represented a range of articulation from normal to severely defective.

Observers who judged the samples were university students currently enrolled in an elementary psychology course. For each of the methods of pair comparisons and constant sums a different group of 125 observers was employed. One hundred observers judged by the method of equal-appearing intervals. The equal-appearing intervals data were also used to compute scale values for the method of successive intervals. Evaluations of these methods were made by studying the correlations between sets of scale values, demonstrations of linear or non-linear relationships between sets of scale values, and the presence or absence of internal consistency within sets of scale values.

On the basis of the experimental results, the method of equal-appearing intervals seems to be the most useful for scaling defectiveness of articulation. The scale values obtained by this method were reliable, relatively easy to compute, and in close agreement with the internally consistent scale values obtained by the method of successive intervals.

The scale values obtained by the method of pair comparisons were demonstrated to lack internal consistency; another method of computation which would allow for unequal discriminal dispersions might possibly yield internally consistent scale values. The laboriousness of the method, however, contraindicates its usefulness in general.

The scale values derived by the method of constant sums were quite different from the values derived by the other three scaling procedures. The distribution with clustering of scale values at the extremes of the scale which resulted from the method as used in this study cannot be meaningfully interpreted. Sources of error were not definitely located.

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Behavioral Rigidity In Speech-Handicapped Children

Ervin Kapos

Nicholas A. Fattu

Some of the obstacles encountered in the treatment of speech-handicapped children are their perseveration in fixed patterns and sequences of sounds, and their inability to change readily from one sequence of sounds to another. Perseveration in response patterns is the definition of rigidity, or behavioral stereotypy, as measured by the index suggested by Miller and Frick (*5*). Much has been written, moreover, about the rigidity of aphasics.

The question therefore presents itself: Is there a difference between speech-handicapped subjects and "normal" subjects in general behavioral rigidity, as measured by a non-verbal task? Are there, moreover, any differences in general behavioral rigidity among speech-handicapped subjects that might be related to their specific disorders? If such differences can be shown to exist, then the results of research to discover the manipulatable stimuli that affect behavioral rigidity may have considerable significance for speech therapy.

Apparatus and Measure

Two studies were conducted. The apparatus employed in the first study was a two-switch electromaze analogous to a four-switch maze developed by Kruglak *et al.* (*4*), and to a four-switch maze employed by Fattu, Kapos and Mech (*2*, *3*). The two spring-switches were centered on the side of the maze facing the subject, with a single red light between and slightly above them. The problem facing the subject on each trial was to find the one switch that illuminated this light. Illumination of the light terminated a trial, and the next one began when the experimenter extinguished the light, thus setting up the next solution. The maze was constructed with a repeating series of 24 randomly selected solutions built into it.

The apparatus employed in the

Ervin Kapos (B.A., Indiana University, 1954) is completing work on the Ph.D. degree in Mathematics, and is associated with the Institute of Educational Research as an independent researcher in various areas, including behavioral rigidity. Nicholas A. Fattu (Ph.D., University of Minnesota, 1942) is Professor of Education and Director of the Institute of Educational Research at Indiana University.

second study was the four-switch maze employed in previous investigations by Fattu, Kapos and Mech (*2, 3*). Housed in a case similar to that of the two-switch maze, this electromaze had four switches with adjacent red lights arranged at the vertices of a square on the side facing the subject. All four lights illuminated when the subject depressed the correct switch a single time. The task was to find the correct switch. As in the case of the two-switch maze, extinction of the lights indicated that the next trial could begin.

The index of behavioral stereotypy proposed by Miller and Frick (*5*) is essentially a measure of the predictability of a given response in a chain, when a fixed number of responses preceding it are known. Clearly, this predictability depends on both the number of possible alternatives, *a*, for the response and the relative frequencies with which these alternatives occur. The index is defined in terms of a property of any sequence of s ($s \geq 1$) responses in the chain called its uncertainty (U). This quantity is related directly to a and inversely to s; for fixed a and s, U is maximum when all alternatives are equally probable.

Miller and Frick show that the s-th order of approximation for U may be written as:

$$U_s = -\Sigma\, p(Q_i,R_j) \log_2 p_{Q_i}(R_j),$$

where $p(Q_i, R_j)$ is the probability that the sequence Q_i will occur and will be followed by the event R_j while $p_{Q_i}(R_j)$ is the probability that a given occurrence of the sequence Q_i will be followed by the event R_j. The quantity U_s may be interpreted as the uncertainty with which a given response can be predicted when the preceding s-1 responses are known.

The ratio U_s/U_{max} provides a measure of uncertainty that is independent of a and is called the *relative* uncertainty. The index of behavioral stereotypy, finally, is defined as $C_s = 1 -$ (relative U_s). For the case of binary data, valuable computational simplifications have been suggested by Newman (*6*).

Subjects

The subjects were 42 patients at the Indiana University Speech Clinic, and 42 'normal' (*i.e.*, without obvious speech defects) pupils who came from schools serving the university community. Twenty-seven of the speech-handicapped subjects were used in the first study and 15 in the second. The sample for the first study included 21 boys and six girls, ranging in age from five years and six months to 19 years and nine months at the time of testing, with a median age of eight years and 10 months. Eighteen of them were in-patients of the Clinic, while nine were out-patients. Table 1 summarizes the data on their disorders and ages, as listed by the Speech Clinic.

TABLE 1. Distribution by age and type of disorder of speech-handicapped subjects in the study which utilized the two-switch electromaze.

Disorder	*n*	*Median Age*	*Range of Ages*
Delayed speech	8	9.08	8.25–11.75
Cerebral palsy	6	5.83	5.50–6.83
Aphasia	5	7.58	7.17–8.83
Defective articulation	4	15.58	13.17–17.58
Other	4	15.42	12.67–19.08

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TABLE 2. Distribution by age and type of disorder of speech-handicapped subjects in the study which utilized the four-switch electromaze.

Disorder	*n*	*Median Age*	*Range of Ages*
Delayed speech	1	7.75	—
Aphasia	3	11.33	8.08–12.50
Defective articulation	9	7.42	5.58–10.83
Other	2	12.83	12.17–13.50

TABLE 3. The *t*-test for the difference in mean index of stereotypy obtained on the two-switch electromaze between males and females among the speech-handicapped subjects.

Group	*n*	*M*	*S.D.*	*t*
Males	21	0.160	0.126	0.66
Females	6	0.207	0.204	

It is readily apparent from inspection of Table 1 that the subgroups with various disorders differed substantially in age, and this may appear to be a significant secondary variable in the study. However, an unpublished study by the authors, utilizing over 500 subjects, has failed to yield any measurable relationship between age and behavioral sterotypy, as measured by the two-switch electromaze.

The sample of speech-handicapped subjects for the second study included five boys and 10 girls, ranging in age from five years and seven months to 13 years and six months at the time of testing, with a median age of eight years and three months. Table 2 summarizes the data on their disorders and ages, as listed by the Speech Clinic. The samples of normal subjects in both studies were matched to the samples of speech-handicapped subjects in both age and sex.

Procedure (Study 1)

Upon entering the testing situation, each subject was informed that the object of the experiment was to see how few responses would be required to solve a series of 'problems' on the two-switch electromaze, the operation of which was explained and demonstrated. The subject was *not* told that the solutions were in random order, and he was required to continue responding until 102 responses had been obtained. These responses furnished 100 sequences of three responses for the computation of the third-order index of stereotypy, C_3.

An average of 1.5 responses would be required to solve each problem in a random series on the two-switch electromaze. The series of 24 random solutions was thus repeated roughly three times to obtain the 102 responses, and this repetition was not considered sufficient to provide a sequence of solutions recognizable by the subjects.

Results (Study 1)

A *t*-test (Table 3) was first computed for differences between male and female subjects in the group of handicapped subjects. The lack of significant differences between the sexes suggests that no distinction need be drawn between male and female subjects in ensuing sections of the analysis.

An analysis of variance was next computed for differences in index of stereotypy between groups of subjects with various disorders. Table 4 again indicates the grouping of the

TABLE 4. Means and standard deviations of indices of stereotypy obtained on the two-switch electromaze for groups of speech-handicapped subjects with various disorders.

Group	*n*	*M*	*S.D.*
Delayed speech	8	0.141	0.136
Cerebral palsy	6	0.225	0.189
Aphasia	5	0.186	0.113
Defective articulation	4	0.135	0.152
Others	4	0.163	0.105

sample of 27 speech-handicapped subjects, and presents the means and standard deviations of the indices of stereotypy for each group.

The value of F, .31, obtained in this analysis, which is summarized in Table 5, was less than 1.00 and not significant. It thus appears to be impossible to differentiate between various disorders on the basis of behavioral rigidity, as measured by the two-switch electromaze and the Miller-Frick index of behavioral stereotypy.

Finally, the indices of behavioral stereotypy were compared for the speech-handicapped group and the 'normal' group. Inspection of Table 6 shows that the means for both groups were 0.170, with only a minor difference in the standard deviations. It follows from this that no significant differences exist between the two groups.

TABLE 5. Analysis of variance for differences in indices of stereotypy obtained on the two switch electromaze between groups of speech-handicapped subjects with differing disorders.

Source of Variation	*d.f.*	*Sum of Squares*	*Mean Squares*	*F*
Total	26	0.594	...	
Between groups	4	0.031	0.008	0.31
Within groups	22	0.563	0.026	

TABLE 6. Means and standard deviations of indices of stereotypy obtained on the two-switch electromaze for speech-handicapped and 'normal' subjects.

Group	*n*	*M*	*S.D.*
Handicapped	27	0.170	0.148
Normal	27	0.170	0.122

It appears, therefore, that speech-handicapped subjects do not differ from 'normal' subjects in general behavioral rigidity, as measured by the methods employed in the present study. Moreover, no significant differences are apparent among groups of speech-handicapped subjects with differing disorders.

Procedure (Study 2)

In view of the results of Study 1, it was decided to compare the indices of rigidity of speech-handicapped and 'normal' subjects as determined by their responses to the four-switch electromaze. The subjects employed in Study 2 were not the same as those employed in Study 1.

Each subject was required to continue responding until 201 responses had been obtained. These furnished 200 sequences of two responses for the computation of the second-order index, C_2. (The number of classes into which the sequences are placed is a^2; this accounts for the larger number of responses required for C_2 on the four-switch maze than for C_2 on the two-switch maze.) In an earlier study, Fattu, Kapos and Mech (*3*) found a correlation of 0.905 between C_2 and C_2 obtained from responses on the four-switch maze.

TABLE 7. The *t*-test for the differences in mean indices of stereotypy obtained on the four-switch electromaze between males and females among the speech-handicapped subjects.

Group	*n*	*M*	*S.D.*	*t*
Males	5	0.225	0.156	0.41
Females	10	0.266	0.175	

TABLE 8. The *t*-test for the difference in mean indices of stereotypy obtained on the four-switch electromaze between speech-handicapped and 'normal' subjects.

Group	*n*	*M*	*S.D.*	*t*
Handicapped	15	0.252	0.170	3.12*
Normal	15	0.098	0.022	

* Significant at the 0.01 level of confidence.

Results (Study 2)

As in Study 1, a *t*-test was first computed for differences between male subjects and female subjects in the speech-handicapped group (Table 7). The result confirms the absence of sex differences in rigidity for speech-handicapped subjects.

Inspection of Table 2, which presents the distribution by type of disorder of the sample of speech-handicapped subjects, shows that the analysis for differences in stereotypy related to type of disorder as carried out for Study 1 cannot be replicated in the present case. Only one subject had delayed speech, none had cerebral palsy and three were aphasics; on the other hand, nine subjects, or 60% of the sample, had defective articulation. (There were also two subjects with other disorders.) Thus the only meaningful comparison lies between the group of subjects with defective articulation and the group of aphasics. Since it is clear that none of the conventional parametric statistics are suitable for an analysis of this nature, the groups were compared by means of the Mann-Whitney statistic. The obtained value of U, which was 12, is not significant for groups of three and nine cases, respectively, and thus enables us to conclude that these groups of subjects do not differ in behavioral rigidity. Although we must therefore assume that the index of behavioral stereotypy obtained from testing with the four-switch electromaze does not discriminate between different disorders, it is clear that additional data are needed to confirm this result.

The result of the *t*-test for differences in indices of sterotypy between the group of speech-handicapped subjects and the group of normal subjects is presented in Table 8. The obtained value of *t* was 3.12, which is significant beyond the 0.01 level of confidence. In view of the considerable divergence between the variances, the Mann-Whitney statistic was also applied to the data. The obtained value of 177 for U, with $n = m = 15$, is likewise seen to be significant at the 0.01 level of confidence, according to the tables compiled by Auble (*1*).

Conclusions

It thus appears that there is a significant difference between speech-handicapped and 'normal' subjects in indices of stereotypy computed from responses to the four-switch maze, though the mean indices for the two groups were identical in the case of the two-switch electromaze.

The sample of 'normal' subjects was

matched to the sample of speech-handicapped subjects in age and sex. Due to the evident difficulties in interpreting precisely the intelligence test data for the speech-handicapped subjects, no such matching could be done on the basis of intelligence.

The authors inspected the available data concerning intelligence tests administered to the speech-handicapped subjects who participated in the two studies. (Scores for the Wechsler Intelligence Scale for Children were available for most subjects.) Since the patients admitted to the University's Clinic are usually severely handicapped, the quotients obtained from the Verbal Scale, which were naturally rather low, cannot be considered a good measure of intelligence. However, the quotients obtained from the Performance Scale were well distributed, with both mean and median around 100.

It is the opinion of the authors, therefore, that the greater rigidity shown by the speech-handicapped sample in the more complex multiple-choice situation should not be ascribed to differences in level of intelligence between the group of handicapped subjects and the group of 'normal' subjects.[1] It appears that the more complex task results in discrimination between speech-handicapped and 'normal' subjects, but a firm statement concerning this must await further data.

[1] C_3 for the two-switch electromaze is not commensurable with C_2 for the four-switch maze, because of the differing orders of approximation. However, the C_2 means for the two-switch maze were 0.148 for the handicapped group and 0.112 for the 'normal' group. Comparison of these means with the C_2 means for the four-switch maze shown in Table 7 indicates only a very small difference for the 'normal' group, but a considerable increase from the two-switch maze to the four-switch maze for the handicapped group. A *t*-test for differences between these two means for the handicapped group gives a value for *t* of 1.99, which is significant at the 0.01 level for 40 *degrees of freedom.*

Summary

Two studies were conducted. In Study 1, 27 'normal' subjects and 27 speech-handicapped patients of the Indiana University Speech Clinic were tested for behavioral rigidity on a two-switch electromaze. No significant differences were obtained in third-order Miller-Frick indices of stereotypy between male and female speech-handicapped subjects, among groups of speech-handicapped subjects with differing disorders, or between handicapped and 'normal' subjects.

In Study 2, 15 speech-handicapped subjects and 15 'normal' subjects were tested for behavioral rigidity on a four-switch electromaze. No differences were obtained between male and female speech-handicapped groups, or between speech-handicapped groups with differing disorders. However, a difference significant at the 0.01 level of confidence was found between the speech-handicapped group and the 'normal' group, with the latter group exhibiting the lower mean index of behavioral stereotypy.

Acknowledgements

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Stuttering As Conflict: I. Comparison Of Therapy Techniques Involving Approach And Avoidance

Joseph G. Sheehan

Robert B. Voas

In speech clinics throughout the country, stutterers can be found practicing various grimaces, or repeating or prolonging syllables, in an effort to free themselves from the handicap. The experimental evidence underlying all this activity is rather slim, and the theoretical structure is a skeleton with most of the bones missing.

In the treatment of stuttering, we do not know why these practices should work, or whether they really do. Historically, the technique is linked to Knight Dunlap and his concept of negative practice. Shortly after the appearance of Dunlap's book, *Habits, Their Making and Unmaking* (*2*), speech pathologists at the University of Iowa, notably Van Riper, Johnson, and Bryngelson, applied the idea of negative practice to the treatment of stuttering.

As originally formulated, Dunlap's negative practice stressed the conscious and exact duplication of the usually habitual act. In speech therapy with stutterers at Iowa, Dunlap's technique underwent modifications, such as the 'bounce' or voluntary syllable repetition. An excellent review of Dunlap's work on negative practice and subsequent experimentation has recently been published by Lehner (*6*). Case (*1*) and Fishman (*3*) reported that Dunlap's technique helped mild stutterers but not 'speech blockers' (presumably more severe stutterers). Though Meissner (*9*) reported voluntary s y l l a b l e repetition or 'bounce' to be effective in reducing stuttering, Oxtoby's data on a similar comparison failed to show significance (*11*). Thus, while the 'bounce' has continued to be used widely in clinics, solid statistical evidence that it is effective has been lacking.

Clinics presently employ different techniques of negative practice, even in the absence of experimental evidence, because the techniques have appeared to help some stutterers. Experimental evidence on the relative effectiveness, if any, of different techniques of negative practice would be a real contribution to clinical practice.

On theoretical grounds, it is per-

Joseph G. Sheehan (Ph.D., Michigan, 1950) is Associate Professor of Psychology, University of California at Los Angeles. Robert B. Voas (Ph.D., UCLA, 1953) is Research Psychologist at the U. S. Navy Medical Research Institute, Bethesda, Maryland. This article is based on a paper presented at the American Speech and Hearing Association Convention in Los Angeles in November, 1955.

haps even more important to secure data on the effectiveness of negative practice techniques:

1. *As a test of the conflict hypothesis in the approach-avoidance conflict theory of stuttering* (*12, 13, 14*). Some speech therapy techniques may be viewed as involving approach behavior, while others involve avoidance. Theoretically, there should be an opposite effect of using negative practice on primary as contrasted to secondary stuttering patterns. Secondary stuttering behavior involves acts of avoidance which are essentially irrelevant to the act of speaking (*14*). The primary symptoms of repetition and prolongation of syllables involve a type of approach behavior which *is* a relevant part of the act of speaking. The strengthening of such approach behavior should enable the stutterer to speak better, while the practicing of avoidance should increase conflict (holding back) and make the stutterer's speech worse.

2. *As a test of the fear-reduction hypothesis in approach-avoidance conflict theory* (*13, 14*). According to the fear-reduction hypothesis, the act of stuttering reduces fear and results eventually in increased fluency. If this is true, then deliberate stuttering should reduce fear more quickly. The act of stuttering may reduce fear in the same manner as compulsive handwashing (*5*).

3. *As a test of functional autonomy in stuttering.* It has been suggested that the fear in stuttering can become self-perpetuating. Once the stutterer develops fear, it keeps itself going. The stuttering is perpetuated according to immediate situational cues and reinforcers, rather than by deeper needs. In the negative practice technique, only the external situation is changed, not the deeper need. Therefore, if stuttering is reduced or eliminated by this technique, this result would support the position that stuttering is primarily a reflection of situational factors rather than underlying needs.

4. *As a test of reinforcement in stuttering.* Practice of the stutterer's secondary symptoms (as in the Dunlap technique) should involve a reinforcement of the stuttering, since at least the *observable* behavior is identical with the actual stuttering pattern. If the last response before a stutterer speaks the feared word is the one most strongly reinforced, in accordance with the gradient of reinforcement (*10*), then this response and the ones immediately preceding it should be strengthened rather than weakened. On the other hand, Luper's (*8*) recent results have caused him to question the applicability of the gradient of reinforcement concept to stuttering. However, it would appear from reinforcement theory that Dunlap's technique should make the stutterer worse.

This study sought to test the foregoing hypotheses by comparing the effect on stuttering adaptation of three different techniques of negative practice currently used in speech therapy for stutterers. These techniques are: (1) imitation of the actual stuttering pattern (Dunlap's technique), (2) bounce (voluntary syllable repetition), and (3) slide (voluntary prolongation). The study further sought to determine what effect the point of application of a negative practice technique has. Should negative practice be used primarily on the same words on which stuttering ordinarily occurs? Would it be more effective as a fear-reducer if used on the preceding word or should negative practice be

TABLE 1. In this experimental design each subject read all four passages six times, applying one method at different points. C, P, R, and S refer respectively to different points of application of the method: Control, Preceding, Random, and Same. The entire design was replicated once.

Methods	*Subject*	*Passages* *I*	*II*	*III*	*IV*
Imitate,	1	C	P	R	S
Bounce,	2	R	S	C	P
or Slide	3	P	C	S	R
	4	S	R	P	C

applied on non-feared words as well —perhaps randomly throughout all speech?

Procedure

The subjects in this experiment were 21 male and 3 female stutterers, ranging in age from 15-40 years. The subjects were just entering upon a program of therapy. The materials used were four 200-word reading passages, roughly equated for word difficulty and verbal content.

The design of the study is outlined in Table 1. The 24 subjects were run in two series of 12 each, permitting one replication of the entire design. The subjects in each series were assigned randomly to three 'blocks' as shown in Table 1. Each block of four read under one experimental condition and under a control condition. Since the entire design was replicated once, there were two such 'blocks' for each experimental method. Thus eight of the 24 subjects made up an imitate group, eight a bounce group, and eight a slide group.

Each member of the imitate (or bounce, or slide) group performed on four different passages. Each passage was read six consecutive times. One of the four adaptation readings was used as a control (C), while the other three involved different points of applying the same speech therapy method. These were designated as Same (S), Preceding (P), and Random (R). For example, subject 1 in the imitate group first read Passage I six times as a control (C), then Passage II imitating his own stuttering on the words *preceding* those on which he previously stuttered (P), then Passage III imitating on *randomly* marked words (R), and finally Passage IV imitation on the *same* words previously stuttered (S). As can be seen from Table 1, the passages were always read in the same order. However, the order of the control and point of application conditions were varied in four sequences. This design, which corresponds to Lindquist's Mixed Design, Type IV (7), permits the determination of the effects of therapy method independent of other variables in the experiment. Among these are passage and passage order effects, and point of application of the method – whether before difficult words, on difficult words or randomly throughout speech. On the assumption of zero interaction, the design permits the testing of other effects besides method.

The experimental procedure was as follows. The subject sat opposite the experimenter and read into the microphone of a tape recorder. The experimenter underlined all words on which the subject stuttered, using identical copies of the passages read by the subject. Under the control condition, the subject simply read the passage six consecutive times, as in any standard adaptation study. Under the experimental condition, the first and sixth readings were control readings used as a pre-test and post-test for the experimental effect. Readings number

two through five involved the actual use of the experimental techniques. Prior to the first reading, each subject was taught to imitate his own stuttering (or to bounce or to slide). Then he was given a practice period in which he rehearsed until he had satisfied the experimenter that he was sufficiently accomplished in the technique for the purpose of the experiment. After the first reading, during which the experimenter marked stuttered words, the subject was handed the experimenter's marked copy, and began using a negative practice technique on the words indicated.

The general instructions were as follows: 'You will be asked to read different passages several times. From time to time you will find words underlined. When you see underlined words, you are to (bounce, slide, imitate own block). Let's see whether you know how to do this.' (A practice period followed, in which the examiner demonstrated the technique and the subject practiced examples. For the imitate group, a mirror was used in practice.)

The specific instructions for the *control* condition were as follows: 'Read this passage aloud in the way most natural for you at this time. Read at your normal rate and do not fake any stuttering that would not otherwise occur. Do not use any special techniques to control your blocks.'

For each *experimental* condition (imitate, bounce, or slide), instructions were given. Before the *first* reading, the control instructions quoted in the above paragraph were issued. Before the *second* reading the following instructions were given: 'On this next sheet you will find words underlined. On these words you will (bounce, slide, imitate). Remember to read the rest of the passage normally as you have before'; before *third*, *fourth* and *fifth* reading: 'All right. Read this passage again (bouncing, sliding, or imitating) on the underlined words'; before *sixth* reading: the control instructions were again given.

One performance measure was taken: the occurrence or absence of stuttering. The speaking of a word by the stutterer under control conditions (readings 1 and 6) was judged an instance of stuttering if he hesitated longer than usual, demonstrated tonic or clonic blocks, or used a special technique. Under all experimental conditions on readings 2 through 5, the experimenter had the task of judging 'genuine' or uncontrolled stuttering, as opposed to 'voluntary' stuttering. In the case of bounce and slide performances, the discrimination was fairly simple. In the case of the imitate performance, the judgment between controlled and uncontrolled blockings was much more difficult.

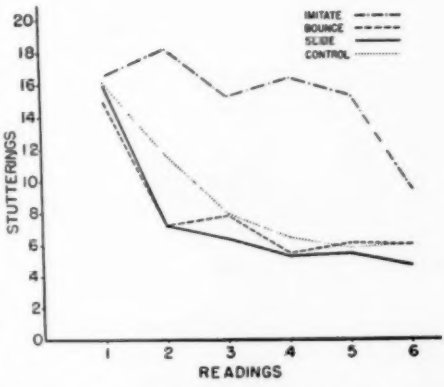

FIGURE 1. Comparison of the reduction in stuttering produced by three therapy methods.

TABLE 2. Comparison of therapy methods.

Method	*Readings*						*Improvement Between Readings 1-6*	
	1	*2*	*3*	*4*	*5*	*6*	*Raw Score*	*Percentage‡*
Imitate*	16.6	18.3	15.4	16.5	15.4	9.5	7.1	43.1%
Bounce*	15.0	7.3	7.9	5.5	6.1	6.0	9.0	62.5%
Slide*	16.0	7.3	6.4	5.3	5.5	4.7	11.3	70.2%
Control†	16.2	11.7	8.0	6.5	5.8	6.0	10.2	65.4%

* Mean raw scores on a total of 24 readings by 8 subjects.
† Mean raw scores on a total of 24 readings by 24 subjects.
‡ The figures in this column give the average of individually calculated percentages.

Despite extreme care exercised by the experimenters on these judgments, the possibility remains that readings 2 through 5 under imitate are spuriously high. However, the initial and final readings (1 and 6) were under strictly comparable (control) conditions for all groups. In an independent check, the experimenters established sufficient reliability in making these judgments for the purpose of the experiment.

Results

The obtained data were treated in two ways, in terms of raw scores and in terms of percentage of improvement between readings 1 and 6. These data are summarized in Tables 2 and 4 and Figures 1 and 3. It can be seen from Figure 1 and Table 2 that the three groups of eight stutterers each began reading 1 at approximately

TABLE 3. Analysis of variance results. This table presents results in terms of percentage improvement, readings 1 *vs* 6. The analysis was carried out according to Lindquist's type IV design (*7*).

Source	*df*	*ms*	*F*	*P*
Between subjects	23			
Methods	2	4125.32	7.75	< .01
Passages X Applications (b)	3	3467.28	6.51	< .01
Passages X Applications X Methods (b)	6	1313.52		
Error (b)	12	532.48		
Within subjects	72			
Passages	3	985.25		
Applications	3	280.92		
Passages X Applications (w)	6	677.83		
Passages X Methods	6	675.62		
Applications X Methods	6	1001.87		
Passages X Applications X Methods (w)	12	998.70		
Error (w)	36	690.37		

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TABLE 4. Comparison of point of application.

Point of Application	*Readings*						*Improvement Between Readings 1-6*	
	1	*2*	*3*	*4*	*5*	*6*	*Raw Score*	*Percentage†*
Same*	17.9	11.2	11.3	9.1	8.9	7.6	10.3	[illegible]0%
Preceding*	15.4	9.3	9.2	8.9	9.2	6.6	8.8	57.6%
Random*	14.5	12.1	9.5	9.2	8.9	6.1	8.4	59.0%
Control*	16.2	11.7	8.0	6.5	5.8	6.0	10.2	65.3%

* Each of the means is based on a total of 24 readings by 24 subjects.
† Percentages given in this column are computed on each individual and then averaged.

the same level. Striking differences in the experimental conditions are immediately evident on reading 2, which is the first reading under the experimental set. The primary symptom techniques, bounce and slide, reduce stuttering somewhat more quickly than do the control conditions. However, this advantage for the bounce and slide methods disappears by the third reading.

Significantly more speech blocks were obtained on readings under the imitate than under the other three conditions. As noted above, the experimenters encountered some difficulty in distinguishing between 'genuine' and 'voluntary' stuttering when the subject was imitating his own stuttering pattern. A portion of the difference between the imitate and other conditions in instances of stuttering on readings 2 through 5 may be due to this artifact. That this factor cannot account for the entire difference is indicated by the results for the sixth reading. On this reading, in which the conditions were the same for all groups, those subjects which had used the imitate method continued to stutter significantly more.

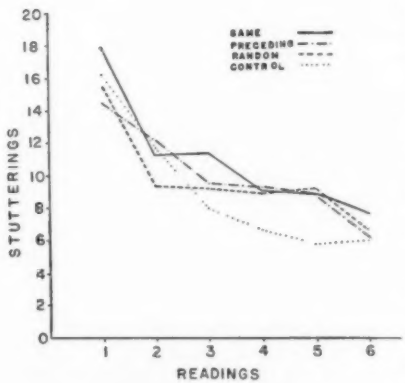

FIGURE 2. Comparison of the reduction in stuttering produced by applying therapy at three different points.

The last column in Table 2 gives the percentage decrease in stutterings on readings 1 *vs* 6. These data were treated by analysis of variance technique described by Lindquist (7). The results of this analysis appear in Table 3.

For the comparison of the experimental methods and control conditions, the principal findings are: (1) The imitate method was significantly worse than the bounce, slide conditions; (2) No therapy method was significantly superior to straight adaptation readings.

A second concern of the experiment related to the comparative effects of applying these different negative practice techniques at different points throughout speaking. The comparison of using negative practice on the same words, preceding words, or randomly chosen words is shown in Figure 2 and Table 4. The control curve for Figure 2 is the same as in Figure 1, since it is based upon the same data. However, the experimental curve data have been arranged somewhat differently, according to the experimental design which permitted this separate comparison. It may be seen that the curves for different points of application of the therapy methods parallel each other closely. The analysis of variance (see Table 3) shows that none of these differences are statistically significant. The chief finding of interest in relation to point of application of different therapy methods is shown by Figure 3. There the data are presented in terms of percentage improvement, rather than number of stutterings. The S, P, R, and C on the abscissa refer to the different points of application of the particular method; namely, Same, Preceding, Random, and Control. From Figure 3 it may be seen quite readily that the least percentage improvement occurred when the imitate technique was used on the word preceding the feared word, while the greatest percentage improvement was obtained by using a slide just prior to the feared word. Care must be exercised in interpreting this figure, since the interaction between method and point of application was not significant. From Figure 3, however, it is apparent that the Dunlap technique, while worse than bounce or slide on all applications, was particularly harmful when applied to the preceding word. Individual *t*-tests indicated that the Dunlap technique's effect when applied on the preceding word accounts for its being significantly worse than the other methods, as Figure 1 showed. Imitate did not differ significantly from the others, at the other points of application.

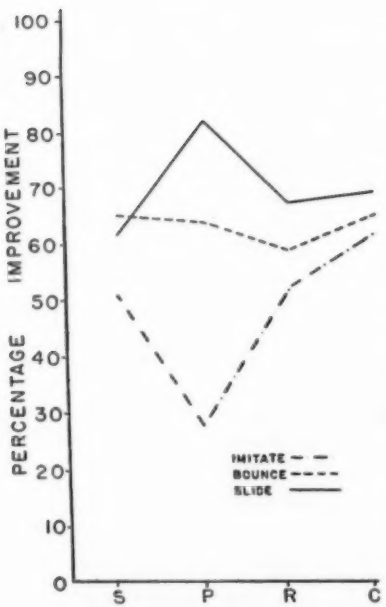

FIGURE. 3. Percent improvement in stuttering in relation to therapy method and point of application.

The analysis of variance presented in Table 3 demonstrates that the between subjects component of the passage interaction was significant. The within subjects component of this interaction was not significant. No satisfactory explanation of this finding can be advanced at this time.

Since the improvement with the

slide method (applied on the preceding word) approaches statistical significance, this procedure appears definitely promising. As can be seen from Figures 1 and 3, the slide technique produced the greatest percentage improvement of those studied.

Discussion

From the results, it is apparent that there are marked differences in the effect of different speech therapy techniques on stuttering. It is clear that subjects who operated under Dunlap's method stuttered more and adapted less. This difference was still evident on the final reading, even after the removal of the experimental set. Asking a stutterer to imitate his own stuttering, which is unpleasant, may increase the penalty on stuttering. The imitate technique then, for the naive stutterer at least, may involve making him perform the hated act. To the extent that imitate involves penalty, the increased stuttering under this technique fits in with previous studies (*13*) showing the relationship between stuttering, penalty, fear, and approach-avoidance conflict.

Devotees of negative practice may argue that while the initial reaction to the Dunlap technique may be destructive to the stutterer's fluency, with continued use the technique would prove beneficial. Here we function with the limitation of any experimental attempt to test therapeutic techniques: in order to get rigorous design and proper control of time variables, it is necessary to limit the period of time over which the technique is sampled. The alternative is a loosely designed 'clinical' test sprawling over a period of weeks and months, leaving the results at the mercy of all sorts of intercurrent events in the lives of the subjects. Even such a 'clinical' test might involve a sampling less than the theoretical optimum. It is possible that the experiment allows the subject less than the optimum amount of practice; however, speech assignments in actual clinical practice are subject to the same limitation. Moreover, for motivational purposes, the stutterer should find a particular technique rewarding fairly early, or he will not continue to use it.

Under the sets to stutter voluntarily with primary symptoms (bounce and slide), uncontrolled stuttering was reduced more quickly than under the control condition, though there were no differences in the final level of stuttering after removal of the set. Apparently, bounce and slide speed adaptation but do not determine its limit. In terms of approach-avoidance conflict theory, it should be pointed out that the standard adaptation or 'control' by no means involves a completely neutral set. Standard adaptation necessarily involves attacking fears repeatedly as the passage is read on successive trials. Not only does the stutterer re-enter a feared situation, but again attacks the same feared words. The bounce, slide, and standard adaptation curves may be similar because they all involve attacking fears and strengthening approach tendencies as opposed to avoidance tendencies.

Using the slide just prior to the difficult word brought about the greatest percentage of improvement. This finding is clinically promising. It is probable, in line with the fear reduction hypothesis stated elsewhere (*12*, *13*, *14*), that the greatest improvement under this condition is due to the immediate fear-reducing effect, as well as to a special property of the slide technique as contrasted with the other techniques.

Stuttering behavior may be thought of as involving maladaptive anticipatory startle responses. The principle of maladaptive anticipatory startle has been discussed by Miller (*10*), and is suggested here as an explanation for the superiority of the slide technique. It is quite likely that the stutterer, in attempting to hit a feared word, shows some of the same behavior as a hunter who begins to pull the trigger before he has fully aimed. The hunter who jerks and startles on his gun before he is able to press the trigger is taught *to squeeze the trigger slowly*. When the trigger is squeezed rather than jerked, the proprioceptive cues mediating the startle response are not present and the hunter is able to hit his target. Similarly, when the stutterer tries to jerk out the feared word, the maladaptive anticipatory startle responses prevent success. But when he hits the word gradually with a sliding speech attempt (or slows down the rate of the stuttering), he prevents the internal cues which set off the startle reaction. Hence this type of disruption occurs less frequently when the slide is used.

Summary

Twenty-four stutterers read four 200-word passages six times in a comparison of the effect of negative practice techniques on stuttering. Eight subjects used the Dunlap technique of imitating their actual stuttering pattern. Eight used a voluntary repetition or bounce. Eight used a smooth prolongation or slide. None of the three groups proved superior to a control adaptation reading during a final test trial under control conditions.

Strengthening avoidance behavior by the practice of the secondary stuttering responses (the Dunlap technique of imitating the actual stuttering pattern) significantly retarded the course of adaptation. This effect was particularly apparent when applied to words preceding difficult words. Strengthening approach behavior, through practice of the primary symptoms, (repetition and prolongation, or bounce and slide), speeded adaptation initially, but eventually proved no better than standard adaptation or control readings.

Of the methods studied, slide produced the greatest percentage of improvement. Slide seemed particularly advantageous when used on words just prior to the feared word. Except as noted in the foregoing, it appeared to make no difference whether a speech therapy method was applied on difficult words, on words just preceding difficult words, or randomly throughout speech.

These results suggest that voluntary stuttering techniques involving the primary symptoms, *e.g.*, bounce and slide, are more likely to strengthen approach behavior in the stutterer and are safer for clinical use. They also suggest that getting a stutterer to reenter difficult situations, with or without these techniques, may reduce anxiety and stuttering. On the other hand, utilizing the Dunlap technique of imitating the actual stuttering pattern, thus practicing avoidance responses, may make the stutterer worse or at best retard his recovery.

The findings provide experimental support for the theory of stuttering as an approach-avoidance conflict. When *approach* responses are strengthened, *fluency* increases; when *avoidance* responses are strengthened, *stuttering* increases.

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The Frequency And Duration Of Treatment Sessions In Speech Correction

Eugene T. McDonald

James V. Frick

A review of the textbooks and periodicals in speech correction and audiology indicates that while considerable attention has been given to the type of therapy which should be used for the various speech and hearing disorders, little consideration has been given to what we regard as another important aspect of clinical practice, namely, the frequency with which a patient should be seen and the duration of each session.

The purpose of this article is to advance the proposition that the frequency and duration of therapy sessions *is* an important aspect of clinical practice and to discuss four conditions which might serve as principles in determining how frequently patients should be seen. If this article accomplishes nothing else, we hope it will lead to a re-examination of what might be called a schedule-dominated orientation to therapy as opposed to one where the needs of the patient are considered in scheduling treatment sessions. In the public school speech correction program, for example, the therapist is scheduled to spend a definite amount of time in each school and often is expected to see a certain number of children on each visit. In college clinics, the treatment sessions are fitted into the schedules of therapists who must also meet an academic schedule. In programs conducted by Crippled Children's Societies, speech therapy must be coordinated with occupational therapy, physical therapy and other schedules. There are many other factors such as too large case loads and administrator's attitudes which force therapy into a schedule-dominated orientation which prevents the therapist from being optimally effective.

The four conditions which might guide the therapist in determining the frequency and duration of therapy sessions are discussed below.

1. *When a new patient is being evaluated and a therapy program is being prepared.* Many therapists have felt the need for seeing their patients on several occasions within a short period of time at the beginning of therapy so they can get to know them and to evaluate them more adequately. If this cannot be done, the patients

Eugene T. McDonald (Ed.D., Penn State, 1942) is Professor of Clinical Speech and Speech Education and Director of the Speech and Hearing Clinic, The Pennsylvania State University. James V. Frick (Ph.D., Iowa, 1951) is Associate Professor of Clinical Speech, The Pennsylvania State University.

are not known well enough and early enough. This will sometimes result in the patient's being treated without the therapist first taking a case history, doing a thorough speech evaluation, administering various special tests and completing all the other things which should be done before a plan of therapy can be formulated. Literally months may go by during which the therapist can be aware of only the superficial aspects of the problem.

Two representative cases may be cited where patients received ineffective treatment because the therapist, who was able to see them only once a week, felt that she must hurry and start 'doing something.' The first patient was a nine-year-old girl who markedly distorted almost all the fricatives. Cursory examination revealed a malocclusion of the anterior teeth. The therapist seized upon this dental abnormality as the explanation for the child's articulatory errors and did only a token exploration for other possible etiological factors. It was only after several months of futile endeavors to teach compensatory movements that the therapist discovered almost by chance that the little girl was very deficient in speech sound discrimination ability.

The second example concerns a six-year-old cerebral palsied boy being seen weekly at a university clinic. He had a number of sound substitutions and distortions and there was definite, although only moderate, involvement of the lips, tongue and mandible. Here, again, the cause for the speech problem seemed clear. However, as in the preceding example, the therapist was unable to see any improvement despite the child's eagerness to come for treatment and the mother's apparent willingness to cooperate. After several months of speech therapy, the therapist came to suspect that the mother's acceptance of and affection for the child were only a cloak for stronger feelings of rejection. This suspicion was confirmed after several counseling sessions with the mother who was gradually able to talk about her true feelings for her son and to reveal that she was devoting herself to a younger normal daughter. As his mother began to genuinely accept him, the boy was able to make rapid progress in therapy since he no longer had to compete with his sister by clinging to his 'baby speech.' The treatment for this boy and his mother would have been much more effective if the therapist had not been bound by a rigid schedule and, so, could have felt freer to do a more adequate case study during the early stage of her contacts with this family.

2. *When new skills or attitudes are being learned.* Whether a patient's problem is one of voice, articulation, hearing, stuttering, or the like, he will find it necessary in the course of therapy to master one or more new skills. In the mastery of a new skill, three stages of learning may be recognized:

A. learning the basic abilities requisite to development of the skill,
B. development of the skill,
C. habituation of the skill.

Clinical experience indicates that patients should be seen frequently during the first two of these three stages and that they need be seen less frequently during the third stage. The manner in which the frequency and duration of therapy sessions might be varied in each of these three stages of learning is illustrated in the case of Bill, a ten-year-old boy, with a highly consistent substitution of [θ] for [s].

A. Learning the basic abilities requisite to development of the skill. An exhaustive examination and case history revealed the only significant etiological factor to be an inability to discriminate between [θ] and [s]. It seemed obvious that his discrimination ability would have to be markedly improved before any change in articulation could be expected. (This particular deficiency, of course, is just one of many possible examples of basic abilities requisite to development of a new speech skill.) The first stage of learning was devoted to training in auditory discrimination employing frequent sessions with the therapist. The sessions were of relatively short duration at the beginning of treatment because the demanding nature of the learning task caused the boy to fatigue fairly rapidly. As he became more proficient in discrimination and, thereby, less likely to fatigue, the length of each session was progressively increased.

B. Development of the skill. It is to be understood here, too, that the methods and techniques used with patients for the development of a new skill will vary widely. It so happened in Bill's case that a very thorough phonetic analysis had revealed that he was able to produce the [s] sound correctly when it appeared in the [sw] blend. This phonetic context provided the point of departure for the second stage of learning, namely, development of the skill. During this second stage, Bill was seen for frequent therapy sessions in order to facilitate rapid and lasting acquisition of the [s] sound in all contexts. As in the first stage of learning, the therapist was able to work with him for a progressively longer period of time at each session. When Bill could produce the [s] sound in the controlled clinical situation with a high degree of consistency, he was considered to have completed the second stage of learning.

C. Habituation of the skill. Again, the choice of methods for this stage will depend upon the nature of the problem, age of the patient and other factors. With Bill, several techniques were employed including nucleus situations, humorous self-inflicted penalties and a judicious use of negative practice. The point to be made here is that for the habituation of the new skill, the therapist needed to see Bill much less frequently than during the first two stages of learning.

The function of the therapist in this last stage was to help Bill increase the consistency of correct production in more and more situations. While this stage of learning is certainly of equal importance with the other two, the joint task of the therapist and the patient is a very different one in that it consists of the habituation or the strengthening of an already fairly well established skill. Here, the great majority of the work to be done is carried out in extra-therapy situations by the patient alone; in the first two stages, most of the work has to be done in the therapy situation under the direct guidance of the therapist. This difference means that the therapist need see the patient much less frequently in the third stage and, probably, for a shorter time at each session. Such proved to be the case with Bill who habituated his new speech skill in a relatively short time while being seen much less frequently and for shorter sessions than during the first two stages.

3. *When material which might be traumatic is being discussed or when the patient shows signs of being emo-*

tionally disturbed. When emotional or traumatic material is uncovered during treatment, sensitive therapists often feel it desirable to see the patient again within a short time in order to capitalize on this occurrence and to prevent the development of undue anxiety. This point is illustrated by the case of a stutterer who suddenly gains insight into the strong possibility that his stuttering has been serving as an excuse to avoid responsibility. When the first real awareness of this occurs, it may prove to be a very disturbing experience regardless of how carefully his clinician has helped him to the realization. If he will not have another treatment session for several days, the intervening time may be fraught with anxiety which perhaps could be eliminated or minimized if more frequent sessions could be arranged. A case which also illustrates this point was that of an elementary school child who became aware during an early therapy session of the effect his articulatory defect had on the intelligibility and the pleasantness of his speech. He became depressed and stopped talking because he feared people would think he was mentally defective or would laugh at him. Since his therapist had him scheduled only once every two weeks, he retained these feelings for several months before he made enough progress to be able to evaluate his problem more objectively.

4. *When the patient is not yet able to assume responsibility for his own progress.* One of the most basic aims of the therapist is to help the patient assume as much responsibility as possible for his own treatment and improvement. It is hoped that the patient will become progressively less dependent on the therapist and, at the time of discharge, be completely independent and ready to carry out the terminal stages of treatment with only occasional supervision. Obviously, there are many factors in addition to the frequency with which the patient is seen which influence this progression from dependence to independence. However, clinical experience suggests that to a significant degree, the attitudes which a patient develops toward his problem and toward therapy are determined by the frequency of sessions. Most clinicians who work with adolescents or young adults have seen patients with histories of several years of treatment on a once-per-week basis. Oftentimes these patients have made very little improvement and they are pessimistic about the prognosis for additional therapy. They feel that since their problems have not responded to 'several years' treatment, their defects must be intractable. Inquiry often reveals that such patients have little insight into the objectives of therapy and no real understanding of the rationale underlying the techniques used by the therapist. In view of the relatively long interval of time between sessions, it is not difficult to understand why they have failed to develop independence and responsibility and why they have made limited progress toward better speech. Ideally, perhaps, all patients should receive intensive therapy initially and, as they develop more ability to become responsible for their own treatment and become more independent, they can be seen less frequently. Therapists should be aware of this dependence-independence continuum and should use it as a guide to help determine the frequency of therapy.

Some of the therapists with whom these principles have been discussed have reacted to them as being theoretically sound, but impossible to apply

in practice. Apparently, it is true that there are difficulties in following them in the typical schedule-dominated program. However, if these principles have clinical value, therapists should feel a strong obligation to organize their programs around them rather than uncritically accept a schedule which meets administrative convenience. While the schedule-oriented therapy program permits the reporting of large case loads, it does not permit adequate consideration of children's problems. It is obvious that the latter is the primary concern of critical, conscientious therapists.

Some public school therapists have developed the so-called block program in an attempt to apply these principles in their clinical practice. It is to be hoped that more therapists will try this procedure or experiment with other plans rather than continue to see children 'by the schedule.'

Summary

The proposition is advanced that the frequency and duration of therapy sessions is an important aspect of clinical practice and should be considered as an integral part of clinical methodology by speech and hearing therapists. It is suggested that the practice of scheduling patients routinely on a once- or twice-per-week basis or on any other basis determined by scheduling convenience rather than the patient's needs is unsound. Therapists should work toward scheduling procedures which would permit them to see a patient at short intervals when necessary. The therapist should be able to arrange the schedule so as to meet the problems encountered at each stage of therapy. There is a need for educating administrators to understand and accept this approach.

Four conditions which might serve as principles in determining the frequency and duration of therapy sessions are discussed: 1. when a new patient is being evaluated and a therapy program is being prepared, 2. when new skills or attitudes are being learned, 3. when material which might be traumatic is being discussed or when the patient shows signs of being emotionally disturbed, 4. when the patient is not yet able to assume a high degree of responsibility for his own progress.

Problems In Military Audiometry: A CHABA Symposium*

1. Introduction To The Presentations

J. Richardson Usher

The Armed Forces are in the process of establishing programs designed to test more accurately the hearing of candidates for military service. Questions that are basic to the establishment of such programs are, for example, how accurate must these tests be, what kind of records should result from the tests and how can large numbers of men be tested rapidly and efficiently?

The Armed Forces also have the problem of those men already in service who are developing a hearing loss. How can we most efficiently detect these people without laboriously testing everyone in the Armed Services? How often should personnel be checked for possible losses in hearing and which personnel are most likely to develop such losses?

The Services are now confronted with a rather new phenomenon, that of the continuous exposure of personnel to high-intensity noises of various types. Many questions are at once raised. How long can men be safely exposed to such noises? Will continued exposure affect a man and if so, in what ways? How can personnel be tested to determine if such exposures are affecting them? What kinds of hearing tests should be given to determine if a hearing loss is service-connected?

The 1955 CHABA Annual Meeting discussed a number of aspects of these problems and because of the importance of adequate testing programs in the military services, the relevant material from the CHABA program is

*CHABA is the Armed Forces-National Research Council Committee on Hearing and Bio-Acoustics. Although the symposium was organized by a CHABA Working Group and was a part of the Annual Meeting, the opinions expressed are not necessarily those of CHABA nor of the CHABA Council. The Council hopes, however, that the publication of this article will facilitate the understanding, discussion and the ultimate solution of the practical problems found in military audiometry.

CHABA is composed of civilian and military scientists who answer questions about hearing and bio-acoustics for the Armed Forces. The continuing services of the Secretariat are provided by the Central Institute for the Deaf under a contract with the Office of Naval Research. The contract is supported equally by the Army, Navy and the Air Force.

J. Richardson Usher (Ph.D., Cornell, 1951) is a Technical Writer at the Central Institute for the Deaf and Secretary for the Working Groups in the Secretariat of the Armed Forces-National Research Council Committee on Hearing and Bio-Acoustics. The present report of the CHABA Symposium on Problems in Military Audiometry was prepared under Contract Nonr 1151 (01) Project NR 140-069) between the Central Institute for the Deaf and the Office of Naval Research. Dr. Usher edited the papers for publication and wrote the summaries for each of the manuscripts except that prepared by Dr. Hirsh. Reproduction in whole or in part is permitted for any purpose of the United States Government.

presented here. This represents the drawing together of material that is not all easily available in the regular literature. Material judged to be irrelevant to the main issues was arbitrarily deleted.

A full account of the 1955 Annual Meeting is given in CHABA Report No. 5 (Davis, H., Eldredge, D. H. and Usher, J. R., Editors), The Testing of Hearing in the Armed Services. This is Technical Report No. 8 to the Office of Naval Research from the Central Institute for the Deaf under Contract Nonr 1151 (01), NR 140-069. Copies of the complete report of the meeting may be obtained from the Office of Technical Services, Technical Information Branch, Department of Commerce, Washington, D. C. Those who qualify for the service may write the Armed Services Technical Information Agency, Document Center, Knott Building, Dayton, Ohio.

Reprints of this set of articles and of the article, 'What Is Zero Hearing Loss?,' are available at nominal cost from the office of the Subcommittee on Noise in Industry, North Bonnie Brae, Los Angeles 26, California.

Problems In Military Audiometry: A CHABA Symposium

2. Veteran's Compensations For Hearing Loss

Kenneth O. Johnson

The Veterans Administration and the American taxpayer are directly concerned with the kind of hearing examination given by the Armed Forces at the time of induction and discharge. What the Services do or do not do in the way of audiometric examinations establishes the situation with which the Veterans Administration must deal and for which the taxpayer must pay.

At present, some 71,000 veterans are receiving approximately three and one-half million dollars compensation per month for hearing handicaps. These veterans have defective hearing as their primary disability. In addition to this sum, approximately one million dollars a year is spent for hearing aids, batteries, repairs, *etc.* The total cost for these veterans, exclusive of the cost for travel and medical treatment, is approximately 43 million dollars a year. If adequate audiometric examinations had been given these veterans at the time of their induction into the Services, many of them would not now be receiving handicap payments for 'service-connected hearing loss' and considerable sums of money would be saved annually.

The connecting link between the Armed Forces' hearing examinations and the compensation paid to veterans is Public Law No. 144. The major provisions of this law are:

a. Hearing is presumed to be normal at the time of enlistment unless otherwise noted on the medical report.
b. With few exceptions, defects not noticed at the time of induction will automatically be considered as service-connected disabilities if they are noted at the time of discharge; and
c. During the time of service, any increase in the severity of a defect noted at the time of induction is determined to be an aggravation of the defect, and service connection is given for the aggravation. 'Aggravation' must be awarded in those cases where there is a progression of the defect or disability, unless there is clear and unmistakable evidence that the increase in disability results from the natural progression of the disease or defect.

The nature of the provisions quoted above make it mandatory that the examination at induction and discharge be given as accurately and thoroughly as possible. Inaccurate tests inevitably result in inequities for the veteran and difficulties for the officials charged with the responsibility for determining their entitlement.

Kenneth O. Johnson (Ph.D., Stanford, 1952) was, at the time this paper was presented, Chief of Audiology and Speech Correction in the Physical Medicine and Rehabilitation Services of the Veterans Administration. He will assume the duties of the Executive Secretary for the American Speech and Hearing Association as of January 1, 1958.

The Armed Forces customarily give the classic spoken voice test at the time of induction and discharge. At the time of discharge, or shortly thereafter, a pure-tone examination may be given. If, on the pure-tone test, the subject shows a significant loss, he may be eligible for compensation benefits. This is in spite of the fact that the spoken voice and the pure-tone tests are not comparable. It is, therefore, possible for a person to have 'normal' hearing by the spoken voice test, as measured at both induction and discharge, and yet be rated for disability payments on the basis of a pure-tone audiometric examination. This may occur if the pure-tone test shows a loss confined to 3000, 4000 and 8000 cps and the military records show exposure to intense noise. It is obvious that such a loss could easily have existed before induction into the Services and would not be detected by the spoken voice test.

The spoken voice test makes it extremely difficult, if not impossible, to determine the authenticity or the degree of a service-connected disability. Also, the interpretations of Public Law 144 bring many persons into the compensation category whose right to it is questionable. Otosclerosis, for example, has frequently been determined to be service connected because an increase in disability during service has been determined to be an 'aggravation' of the disability. Veterans in this category receive a total of $40,000 per month. There are, no doubt, hundreds or thousands of veterans diagnosed as 'cause undetermined' or simply as 'deafness,' who are, in fact, receiving a disability for otosclerosis.

In order to implement honestly the laws of presumptive soundness and aggravation, complete, valid and reliable examinations must be given at both induction and discharge. Additionally, the test results obtained by the Armed Forces must permit direct and valid comparisons with those obtained by the Veterans Administration. This is the minimum that must be expected. Ideally, the Armed Forces and the Veterans Administration should have the same test requirements and the same qualifications for examiners, test materials, techniques, procedures and equipment.

The Armed Forces should eliminate the use of the spoken voice test as soon as possible. The expense of purchasing the necessary acoustic equipment for pure-tone or controlled speech tests would be saved many times over by the Veterans Administration. Abandoning the spoken voice test would also result in a more equitable distribution of compensation benefits and the public would benefit from such inter-Agency coordination.

Summary

There are certain inequities that occur in any program for compensating service-connected injuries when the examinations given at the time of induction and discharge are not of comparable accuracy and validity. This is especially true in the field of audiometry where the spoken or whispered voice test may be given at the time of induction and a pure-tone audiometric examination may be given at or shortly after separation from the Service. Since the latter test is a very sensitive examination, it will disclose hearing losses that are not detectable by the spoken and whispered voice tests. It may happen, therefore, that a hearing loss actually present at the time of induction may not be dis-

covered until separation or discharge occurs. When this situation occurs, the law requires that compensation be granted, even though the tests are not comparable in sensitivity and accuracy and the hearing loss was not necessarily caused by any service-connected injury or illness. The Veterans Administration is caught in just this situation and is presently paying large sums of money to veterans who have hearing losses that could not be in any way service connected. For this reason, it is necessary for the Armed Services to give pure-tone audiometric examinations at the time of induction and discharge. Such a change will permit the Veterans Administration and the Armed Services to use the same tests, having the same validity, and make it possible for tests given by the Services to be compared with later tests given by the Veterans Administration.

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Problems In Military Audiometry: A CHABA Symposium

3. Diagnostic Audiometry

Gordon Hoople

Diagnostic audiometry was not used by the medical services of the Armed Forces during World War I and only little use was made of it during World War II. At the present time, the Services are performing threshold audiometry. This is not a sufficient examination for medical purposes, since threshold audiometry does not show *what kind of* a hearing loss a man may have nor how it was caused. Until the cause of the loss is known, the relative importance of a loss cannot be assessed nor can a fair decision be made as to the amount of compensation to which the veteran is entitled. The importance of performing diagnostic audiometry at the time of induction is underscored by the increasing number of veterans who are receiving compensation for hearing losses. At present *any* hearing loss detected at the time of discharge is presumed to be service connected, regardless of its physical origin, unless the induction physical examination notes the presence of a hearing loss.

There are two kinds of hearing losses. The first, conductive loss, is a loss affecting the middle ear. This conductive loss is different from the second kind, nerve (or perceptive) loss which is caused by the deterioration of either the auditory nerve itself or by damage to the inner ear mechanisms. Diagnostic audiometry can distinguish between these two types of hearing loss.

We hear through two separate and distinct channels. The first is by air through the ear canal. The second is through the head, by bone conduction. Air conduction tests are given to determine the degree of hearing in the ear. However, the shape of the audiogram does not yield a diagnosis. Bone conduction audiograms are made to distinguish between conductive and perceptive hearing losses. In this test the ear canal is blocked off and sound is introduced into the inner ear through the mastoid bone by means of a vibrator. If the patient has a pure perceptive hearing loss, the threshold audiogram will be no better than that obtained by air conduction, since it is the inner ear or the auditory nerve itself that is damaged. If the patient has a conductive loss, however, there will be a loss by air conduction, but a

Gordon Hoople (M.D., Syracuse, 1919) is Professor of Otolaryngology at Syracuse University and an eminent clinical otologist. He is at present (1957) a member of the CHABA Council, member of the Committee on Conservation of Hearing and of the Subcommittee on Noise in Industry of the American Academy of Ophthalmology and Otolaryngology and a past president of the American Otological Society.

normal audiogram will be obtained by bone conduction as there is nothing wrong with the inner ear.

Other problems still remain, such as the frequent occurrence of mixtures of conductive and perceptive hearing losses. To determine which type of loss predominates other diagnostic tools are used, such as masking noises, speech audiometry and tests designed to show psychogenic deafness and plain malingering.

The cause for the hearing loss can only be identified through careful case histories, coupled with physical examinations. The importance of a good case history can hardly be overestimated, since the future handling of the case may be based upon it. Properly done, it may save clinic time by showing that certain tests are not necessary. Even though the cause of a given hearing loss is fairly apparent, a good case history still should be taken.

Otosclerosis demonstrates the importance of good case histories, careful physical examinations and the performance of diagnostic audiometry. Otosclerosis is a disease of the ear which first manifests itself in the late teens or early twenties. It is unquestionably an hereditary defect that is neither a service-connected injury nor aggravated by service in the Armed Forces. Diagnostic audiometry can distinguish otosclerosis from other hearing losses, including those injuries to the ear resulting from exposure to noise and blast; yet the Veterans Administration, since 1945, has spent millions of dollars for operations to restore the hearing of thousands of veterans who have otosclerosis. By no stretch of the imagination should the taxpayers be asked to pay for this expensive program. They do pay, however, because the performance of diagnostic audiometry at the time of induction into the services is not mandatory in the Armed Forces.

Only when proper audiometric measurements are made and case histories are taken by the Armed Forces can proper compensation regulations be established. The Armed Forces must, therefore, be willing to perform diagnostic audiometry.

Summary

This paper deals with methods of assessing hearing loss so that the exact type of loss and the probable cause for it can be determined. Both the type and the cause of the hearing loss must be known before intelligent treatment can be undertaken. Fortunately, the pure-tone audiometry mentioned by Dr. Johnson as important for properly assessing claims for compensation is also the first step in a thorough diagnostic survey of hearing. By adding bone-conduction audiometry, speech audiometry, testing in the presence of masking noise, *etc.* to the testing routine, it is possible to distinguish among conductive and perceptive hearing losses, noise-induced hearing loss, otosclerosis, psychogenic deafness and malingering. The information derived from these tests can, therefore, be used to aid in treating a man's hearing loss while he is in the Service and will also assist in establishing any claim for service-connected injury that the man may have.

Problems In Military Audiometry: A CHABA Symposium

4. A Classification Of Hearing Tests

Ira J. Hirsh

This presentation has a two-fold task: first, to examine the reasons why a military agency should test hearing; and second, to classify those hearing tests presently available in order to fit them into military requirements.

There appear to be four general purposes for testing the hearing of military and civilian personnel in the various divisions of the Defense Department:

1. *Initial and periodic physical examinations.* The physical examinations given by the Armed Forces determine the general state of a man's health. Before he can be accepted for service and later to continue in service, he must meet certain physical standards. Formerly, the standards for hearing were written in terms of the whisper and spoken-voice tests. Recently, because of the greater validity of the pure-tone audiogram for reflecting an individual's hearing ability, these standards have been rewritten in terms of hearing loss for pure-tones. It is the task of the physical examiner to place each man in one of the four H-categories in the medical profile. So long as the standards are written in terms of hearing loss for pure-tones, this examination will require tests using pure-tones.

2. *Medical assessment of hearing loss.* If a man develops hearing trouble after he has been accepted for service, the medical officers will want to measure, for diagnostic purposes, the amount of hearing loss. They will want to measure it periodically in order to check on the effects of either his treatment or the environmental conditions that may be producing his hearing loss. The kinds of hearing tests needed in this situation can be selected from those used by practicing otologists and should include fairly complete pure-tone audiograms and certain other more elaborate tests using both pure tones and speech.

3. *Legal assessment of hearing loss.* The legal aspects of service-connected hearing disabilities require that an adequate measure of a man's hearing be made when he enters the service and a similarly adequate measurement be made when he retires or is separated.

Ira J. Hirsh (Ph.D., Harvard, 1948) is a Research Associate at the Central Institute for the Deaf and Associate Professor of Psychology at Washington University.

Comparison of these two tests will show the amount of hearing loss that may be service-connected. The hearing tests made at the time of separation or retirement have been done more carefully than those given at induction and any hearing losses determined at the time of separation have been assumed perforce to be the full responsibility of the military service.

4. *Job classification.* Different types of military assignments may require special abilities in hearing. If and when such abilities are written into job specifications, hearing must be tested in those dimensions in order to determine the qualifications of particular individuals for those particular jobs. The submarine sonar operator, for example, must be able to discriminate between tones of different frequency. The radio operator and aircraft pilot must be able to understand speech while in the presence of high noise levels. Such people should have hearing systems that are naturally tough and resistant to the damaging effects of noise. From the small amount of information that is available, it is apparent that each kind of job is going to require its own specially developed test and that ready-made tests and criteria cannot be borrowed from practising otologists and compensation experts.

Amounts of Hearing

It is difficult to think about any human sense in terms of amount or quantity, but this kind of quantitative thinking must precede any attempt to test that sense. There are very few hearing tests that claim to test how much hearing a listener has. Most of them measure how much sound is required for a certain 'amount of hearing.' Naturally, the amount of hearing to be measured will vary with what is being heard. Thus it is that there are tests for pure-tones, for speech, for watch ticks, *etc.* Almost all of these, however, involve measuring how intense a sound must be for a given amount of hearing.

The most commonly used 'amount of hearing' is called the *absolute threshold* and this may be defined briefly as the weakest sound that can be detected. In the spoken-voice and whisper tests, instead of being measured directly, intensity is measured indirectly as a function of the distance between the talker and a listener. An audiogram gives similar results directly as the measure of the amount by which pure tones must exceed a normal intensity (the normal threshold) for a given listener to hear. Thus, the amount of hearing is usually fixed, involving a listener's response to a sound a certain percentage of the time that the sound is presented.

Like the audiogram, other measures of hearing loss, such as hearing loss for speech, do not tell about the amount actually heard, but instead tell about the physical intensity of a sound that gives rise to a defined response or set of responses. Thus the application of quantitative concepts directly to a human sense is avoided; only the physical attributes of the sound can be measured and what is meant by 'hearing' is therefore an arbitrary definition.

Although this threshold measure is the one most commonly used, there are many instances in which it is not enough. One example is the measure of a person's ability to discriminate speech, which will be discussed below. The insufficiency of the absolute threshold should not be surprising; how much would be known about a man's vision if only his absolute

threshold for light were tested without regard to visual acuity or color vision?

Functions of Hearing Tests

Is He Normal or Not? When physical standards are set by a military agency, the basic question to be answered by any test with regard to these standards results in an all-or-none answer. In the case of hearing, it must be determined whether or not he has a certain specified amount of hearing or, more precisely, whether his threshold lies above or below a standard level. How much he deviates from the standard is not important. Thus, when physical standards for hearing had to do with the conversational voice at a distance of 20 feet from the listener, it did not matter how much closer than 20 feet the examiner had to come; it was only necessary to know whether the man could hear (repeat numbers) at 20 feet or not. Now that the physical standards for hearing have been, or are being, changed to the decibel system, the same principle still applies. If the standard requires that a man have no more than a 15 db hearing loss, it is only necessary to present tones at various frequencies at an intensity that is 15 db greater than that specified for normal hearing and the test results are given in terms of whether or not the listener hears those tones.

The kind of hearing test that provides such a yes-or-no answer is called a *screening test.* Its purpose, like that of a screen, is to separate two groups: one that can hear certain sounds and one that cannot. So long as the physical standards are given in terms of decibels of hearing loss for pure-tones, military screening tests must employ pure-tones.

The fact that a given hearing test is to be used for screening does not mean that it must also be a group test. Screening can be done with either individual or group tests. Indeed, the most commonly used individual screening test employs a pure-tone audiometer in which the same hearing-loss setting (whatever the standard is) is used for all frequencies and the examiner has only to determine with each frequency whether the listener can or cannot hear that tone. But because only one intensity is involved in the screening test, this testing function has been easily adapted in various kinds of group audiometry. This use differs from the individual screening test chiefly in that the fixed intensity at all tested frequencies is presented simultaneously to a group of listeners rather than a single listener. The major complication involved is that the test must be designed for recording simultaneously the responses, or lack of them, from each of the listeners in the group.

The tones used in a screening test may be either continuous or interrupted. Again, the fact that this is a screening test does not dictate which kind of tones should be used. As a matter of actual practice, pulsed tones have been found most convenient to use and, indeed, groups of them are used in such a way that the listener indicates that he has heard by recording how many tone pulses he heard.

A group test, then, does not necessarily mean a screening test. A pulse-tone test does not necessarily mean a screening test. The word 'screening' refers to the purpose of the test and to the fact that it is not concerned with measuring the threshold of hearing; rather, the only concern is to determine whether a given listener's threshold falls above or below the

screening level or standard. The screening purpose may be accomplished with either individual or group tests, but it has been found that when dealing with large groups, one can conserve time by utilizing a group test. Similarly, either continuous or interrupted tones may fulfill the screening purpose, but actual practice has shown the pulsed or interrupted tone to be the more usable stimulus. Finally, both automatic and manual techniques have been employed in the screening of individuals and groups.

How Much Hearing Loss Does He Have? Various kinds of screening tests enable us to state whether or not a man meets certain physical standards for hearing. Suppose, for example, a man has been found who does not meet these standards. In the case of induction or enlistment, the story may end there and the man may be sent home. If he is already in the service, it may be necessary to know the amount by which his hearing is not normal, either for treatment, future assignment or pension purposes at discharge. It is now not enough to say that his hearing loss at some frequency is greater than that set by the standard. How much hearing loss he actually has must be determined.

Almost all the ways of expressing a hearing loss have resulted from procedures that were developed in connection with the medical specialty of otology. Hearing tests have been developed in that field primarily because of their contribution to diagnosis. When these tests are used for purposes other than diagnosis, they may not turn out to be either the most convenient or the most valid, but their widespread use justifies their application in such other areas as reassignment, compensation and rehabilitation.

The basic measure of hearing loss involves pure tones. Results are usually displayed in tabular or graphic form on what is called an audiogram. The quantity measured is the difference in decibels between the threshold for a given patient and the normal threshold specified for audiometers by the American Medical Association and the American Standards Association. A single hearing loss figure cannot be given for all tones. Therefore, the audiogram is used to show hearing losses at different frequencies.

The audiogram may be derived from any of a variety of tests. The most widely used test involves an individual audiogram obtained from a standard audiometer (specified as either a screening or diagnostic audiometer). In this test, the audiometrist sets a given frequency and varies the intensity or hearing-loss control until he finds a level below which the listener never responds and above which he always responds. This is repeated for both ears for as many frequencies as are desired. The listener indicates his hearing by some signal, either the raising of his finger or the pressing of a button.

Automatic audiometers have also been employed to obtain individual audiograms. There are pulse-tone audiometers in which groups of tone pulses are delivered and the listener must respond by saying how many tones are in a certain group. Another example of an automatic audiometer is the one invented by Békésy, in which a mechanism is provided for the listener to change the intensity automatically by pushing a button when he hears and releasing it when he does not. The intensity of the tone is re-

corded on paper as a continuous function of frequency.

Individual audiograms may also be obtained from group tests in which, for example, groups of tone pulses at different levels and at different frequencies are presented to many listeners simultaneously. These listeners write down the number of pulses heard in each group. A comparison of each listener's responses at the levels at which the pulses were presented enables the tester to derive an audiogram for each listener in the group.

Here again, the purpose of a test does not dictate the kind of testing instrument that will be used. A so-called screening audiometer may be used to obtain an individual audiogram. A group test may be devised that will yield audiograms for all members of the group. Finally, individual or group audiograms may be obtained with certain automatic audiometers or also with manually-operated audiometers.

How Well Does He Hear Speech? Unless the concern is primarily either diagnosing a hearing loss or identifying its type and probable cause, some measure of a man's hearing will be needed which will tell how well he does in those situations where he uses his hearing most. For the majority of people it may be assumed that this situation usually involves speech communications. Thus there is ample reason for knowing about a man's ability to hear speech.

In testing a man's hearing for pure tones, a fairly uncomplicated response is involved: namely, to do something when a tone's presence is observed and to do nothing in its absence. In the case of speech, however, it is necessary to know more than whether or not the listener hears something. The problem of identification, if not understanding, is added to the listener's task.

It has been found convenient, in clinical usage, to discuss hearing for speech in terms of two dimensions: one concerning how much intensity must be supplied for a listener to hear and identify a certain amount of speech and the other concerning how much speech he can identify or understand.

An example of the first is found in the old spoken-voice test where a tester varies the distance between himself and a listener (and thus indirectly varies the intensity) until he finds an intensity at which the listener can just repeat words or numbers. This is directly analagous to the more modern test of *hearing loss for speech*, which is defined, as was the hearing loss for a pure tone, as the number of decibels that a listener requires for a certain amount of hearing and/or understanding, relative to the decibels or threshold required by a listener with normal hearing.

Again the threshold is defined in terms of an arbitrary 'amount of hearing,' in this case 50 percent of a list of words. Thus, when a man has a 30-db hearing loss for speech, this only means that we must present speech at a level 30 db higher than that needed for a normal listerer—but both the man and the normal listener hear the same amount and repeat 50 percent of the words.

Intensity is not the only thing required for the understanding of speech. There are other dimensions involving complex discriminations between frequencies, groups of frequencies, simultaneous intensities and tonal complexities, all of which go to make up the recognition of a speech sound, word or groups of words.

Since all of these factors are not yet understood, a man's ability to perceive speech can be predicted only by testing it directly. One useful clinical concept, discrimination loss, involves the measurement of the maximum number of different words that a man can understand, even when the speech is presented at such a high intensity that any more intensity would not make the words any easier to understand. Individuals with exactly the same hearing loss for either pure tones or speech may differ in this ability to discriminate speech sounds and such information has been found useful in diagnosis and prognosis of hearing disorders.

Hearing Tests Applied to Military Use. As a conclusion of this classification of hearing tests, the following is one man's opinion of an over-simplified scheme for the employment of appropriate hearing tests in the Defense Department, holding to the principle that these matters should be as similar among the three Services as possible. Even though this writer has been a member of three CHABA Working Groups that have been asked for specific recommendations on some of these problems, none of these Working Groups are involved in the following statements.

There are some general guide rules for selecting the appropriate test. First, the more people there are who have to take a certain test, the simpler that test should be. Second, the more locations there are at which such a test is to be given, the more independent it should be of the training or education level of the test personnel. Third, the more elaborate and variegated a test must be for certain purposes, the fewer places there should be at which such a test is given.

It should be obvious that the primary purpose of any hearing test conducted at an Armed Forces Examination Station is screening. It is only necessary to know if a man's hearing is acceptable. It is not important to know how much hearing loss he has; if he has more than is allowed by a given standard, he is not accepted. The few Examining Stations visited by members of Working Group 3 had a load of from 200 to 500 men per day. The hearing test was only a small part of the general physical examination and, therefore, not much time could be devoted to it. Under these circumstances a standized group screening test was indicated and, therefore, recommended by Working Group 3 to the Department of the Army. The Working Group recommended that the Army standardize on the group screening technique developed by Dr. Glorig. It is to be hoped that development contracts have been or are being given to prospective manufacturers of equipment that would carry out this test and, equally important, that soundproof space is being made available at these stations so that the validity of these measurements will not be influenced by excessive ambient noise.

The screening that is accomplished at the Examining Station can also be used to assign a man to one of the four hearing categories in the medical profile, but it is doubtful that such categorization is sufficiently precise for the purpose of having an initial record of a man's hearing that will serve as a base against which later claims for lost hearing will be compared. It is not economical to make a detailed audiogram for every candidate for service, because such audiograms are unnecessary for those men

who are rejected. Very few rejections are made at the reception centers on the basis of the physical examination given there. These centers, therefore, would appear to be the logical place to provide for a hearing test that would yield an audiogram in sufficient detail for these legal purposes. There are not many reception centers, but they handle large numbers of men. At such installations, therefore, individual audiometry would be too time consuming, and the development of even very complex automatic machinery should be encouraged if it will permit the recording of audiograms for groups of men listening simultaneously. Such, the writer believes, is the intent of the development programs now under way at the U. S. Air Force School of Aviation Medicine and within the U. S. Navy Bureau of Medicine and Surgery.

The requirements of medical supervision of sick ears imply that an individual diagnostic audiometer should be available to the Ear, Nose and Throat Department of every station hospital. Audiograms obtained at such installations would be used for estimating the amount of hearing loss resulting from some acute injury, exposure or infection and would, in general, serve the same purposes as they do in civilian otologic practice.

Personnel who sustain permanent hearing losses present a real problem. In many instances the capabilities, training and experience of such personnel imply that they should not be separated or retired because their hearing no longer falls in category H-1. Facilities are available at which their hearing can be elaborately studied, recommendations for the use of hearing aids can be made and even training in lipreading, *etc.*, can be carried out. Because of the complexity of the testing program at such a facility, it would not seem wise to have very many such installations. Not only is the equipment costly and the proper space difficult to procure or build, but also sufficiently trained personnel for many such installations simply are not available. Reference is made here to such installations as the Speech and Audiology Center at the Walter Reed General Army Hospital and The Speech and Hearing Clinic at the U. S. Naval Hospital at Philadelphia.

The kinds of tests that might be used to predict special abilities, in particular military specialties, have not yet been mentioned. This was a deliberate oversight, for one would have had to mention a test for every kind of hearing ability that might be called for and space would not permit such a listing. Also, these tests are not "widely used," having been worked out under military auspices, quite outside of a general clinical context.

Such special tests as have been worked out at the Medical Research Laboratory, U. S. Naval Submarine Base, and in the Human Factors Division of the U. S. Navy Electronics Laboratory having to do with the performance of land and sea-based sonar operators probably should not be administered to all Navy enlistees at a large reception center. Rather, they should be given after a group of potential sonar operators has been screened by other, less specialized tests. Similar principles would be applied to the selection of land and aircrew personnel who have to do with radio communication.

Summary

Hearing tests that are presently available include those that come from and are used in medical practice, research laboratories and different train-

ing programs. Not all of these are equally applicable to the several military requirements for hearing tests. Military audiometry should probably serve four purposes: (1) to select or reject men as a part of the regular initial physical examination, (2) to provide for the otologist information on the state, probable cause and progress of a hearing loss, (3) to provide information that can be used in establishing the amount of hearing loss for compensation purposes and the state of the original hearing before the service-connected hearing loss developed, and (4) to enable personnel officers to determine whether or not certain individuals are qualified for certain military specialties that involve special kinds of hearing ability.

Not all hearing tests will suit all of these purposes equally well. The kind of test to be employed for each of these purposes will depend upon: (1) the kind of information that must be obtained from the test, (2) the number of installations at which the test must be carried out, (3) the number of persons who must take the test, and (4) the requirements of the test for equipment, space and trained personnel.

Problems In Military Audiometry: A CHABA Symposium

5. Review Of The 'Report By The Working Group On Military Audiometry'

Raymond Carhart

CHABA Working Group 3 was activated in the spring of 1953 to consider enquiries from the Armed Forces about audiometry in the military services. The Army requested an evaluation of the usefulness of the Glorig screening test; the Navy requested comments on a research proposal for developing an automatic group audiometric screening test; and the Air Force requested comments on certain proposals made by its Ad Hoc Committee on Audiology Problems. The Final Report of the Working Group was presented in October 1953.

The concluding statement in the Report is a logical starting point for the present partial review:

> '. . . consideration of these questions . . . quickly brought us to the view that . . . (the three requests) . . . arise from a common set of problems. Decisions concerning testing techniques (whether screening or threshold type) and decisions concerning test goals (whether involving physical standards, profile categories, or job classification) are not peculiar to any one Service. Research needs in this area are also basically the same.'

It was recognized that an interservice approach would be the most productive method of achieving long-range solutions to these common problems.

In defining the scope of these common problems, the first step was to outline the function of military audiometry. Certain functions of hearing testing common to the three Services were:

> '1. determining whether or not a man meets the physical standards for hearing specified by a Service,
> 2. assigning an individual to a medical-profile category for hearing,
> 3. determining the amount of hearing loss that can be entered as an initial notation in a medical service record as the basis for later comparison in the event of a disability claim, and
> 4. observing periodically the progress of an individual's hearing.'

It was realized that the measurement of auditory capacities for use in selecting personnel for special assignment would be an important function of hearing tests which would vary with the needs of the several Services.

The statements given above show that the Working Group was view-

Raymond Carhart (Ph.D., Northwestern, 1936) is Professor of Audiology and Director of the Hearing Clinic in the School of Speech, and Professor of Otolaryngology in the Medical School of Northwestern University. He is President of the American Speech and Hearing Association.

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ing audiometry as a means of classifying and utilizing large numbers of men more effectively, rather than as a means of diagnosing ear diseases. This emphasis was not a discounting of the diagnostic value of audiometry in the military situation, for it has its definite uses there. Instead, it recognized that the military problem to be solved was that of effectively testing the hearing of a large number of men in a reasonable length of time.

Special difficulties were listed which must be overcome in solving this particular problem. These difficulties are, essentially, the practical restrictions required by realism in the basic planning for a program. It is hardly necessary to observe that a combination of adequate rooms and qualified personnel are required for satisfactory auditory testing and that these requirements are particularly hard to satisfy in many military situations because:

'1. so little testing time per individual is available,
2. tests are often conducted by inexperienced personnel, and
3. tests must often be carried out in small and noisy quarters.'

While a continuous battle must be waged to win sufficient time to test each individual adequately, to insure properly qualified testers and to obtain adequate quarters for the audiometric program, a careful selection among possible procedures must be made in order to keep the demands upon time and money to a minimum.

Any attempt to make recommendations in the realm of military audiometry must recognize the possibility that the Services will differ in regard to the physical standards which are specified, the methods of processing personnel and the use made of test results, whether for physical standards alone or for selection for special assignment. The goal should be to implement the guiding principles with practices which are as uniform as possible, while allowing for modifications where useful.

The Report of CHABA Working Group 3 specifically proposed four steps for the improvement of auditory testing in the Armed Forces:

'1. selecting the test most appropriate for yielding the information desired in a given situation,
2. establishing and maintaining standard test procedures,
3. providing standard equipment and adequate testing rooms, and
4. setting up military specialties (MOS, AFSC, *etc.*) for the personnel required by these programs.'

The above principles and frame of reference were then applied to the request submitted by the Army: should the automatic screening audiometer developed by Dr. Glorig be standardized for use in induction and reception centers?

On the basis of procedures in use at induction and reception stations in 1953, the Report concluded that a screening test of hearing was applicable only to induction centers, usually called Armed Forces Examining Stations.

'1. Such a screening test must:
   a. be simple enough to be understood by all examinees regardless of literacy or intellectual ability,
   b. determine the medical-profile category for hearing to which the examinee should be assigned, and
   c. yield information that will facilitate the proper disposition of claims made for service-connected hearing loss.
2. Present conditions at Armed Forces Examining Stations seem to require that:
   a. the men move through the hearing test station at the rate of about one man per minute,
   b. the results be quickly and easily interpreted and recorded by the examining staff,

c. the test procedures be simple enough to allow untrained personnel to carry them out.

3. Most of . . . (these) . . . criteria are satisfied in theory by the 15-foot whisper test, but the whisper test cannot be adequately standardized, especially with untrained examiners.
4. The use of pure tones is desirable because . . . (it satisfies the criteria mentioned above, and) . . . no extensive vocabulary is required.'

The Glorig screening method was recommended as applicable for use in the Armed Forces Examining Stations. The method was noted as satisfying the criteria for a military screening test better than any other pure tone method known to the Working Group, even though further improvements were needed in the test apparatus. An immediate implication of this recommendation is that physical standards and medical-profile categories must be defined in terms of decibels of hearing loss for pure tones and *not* in terms of distance over which whispered numbers are heard.

Acoustic and other specifications for test locations were recommended. These recommendations emphasized that the physician conducting the otological examination should be supplied with appropriate instructions and manuals to facilitate his supervision of the test procedures.

The question of how best to obtain full pure-tone audiograms on large numbers of men was only partially answered. It seemed obvious to the Working Group that, to be practical, a large scale program had to rely on some method other than conventional pure-tone audiometry administered individually by trained technicians. Some form of group or automatic test was recommended. Another possibility was a combination or adaptation of those types based upon techniques already developed such as the Harris or Webster techniques. An additional possibility, not then fully explored, involved the use of an automatic self-recording technique that could handle a continuous flow of examinees. The Report recommended that, before a final choice was made between the various methods, research should be undertaken to clarify their relative merits, as well as those of simplified versions of individual automatic audiometry. Threshold pure-tone audiometry has extensive military value.

There are fundamental differences between the military and civilian situations in which audiometry is performed. These differences require variations in audiometric techniques. Simply because one method has proved to be highly effective in one circumstance does not mean that it should be the method of choice in another circumstance.

When the administration of pure-tone tests to large population samples is considered, there are three highly independent applications: namely, in the military, in public schools and in industry. Military audiometry, with its emphasis on personnel selection and classification, has already been reviewed. However, the goal of public school audiometry, where the purpose is so pointedly preventive is very different. Children are screened to identify those needing medical care, rather than to discard those who should not be in the organization. Threshold audiometry is done to obtain additional information on those few children who seem to need preventive therapeutic care and there is no concern for special placement of children on the basis of exceptional auditory ability. Instead, the more severe auditory deficiencies are evaluated so as to plan individualized edu-

cational programs for the unfortunate children who possess the deficiencies. Industrial applications of audiometry including the concept of "monitoring audiometry" are discussed in the final paper of this symposium entitled "Audiometry in the Armed Forces."

The important point here is that the Armed Forces can use auditory testing for quite different purposes than are found in civil life. The military services are in the enviable position of being able to establish broad and well conceived programs in auditory testing that might exceed anything found today in civil life.

Summary

The Working Group on Military Audiometry, in reviewing a number of questions presented by the three Armed Services, had concluded that, while the individual problems of the Services might appear to be different because of the differences in internal structure, the problems are basically the same in terms of research needs and the general goals for physical testing. The main goal of military audiometry is to classify and utilize large numbers of men more effectively. Diagnostic audiometry also has its place in military audiology, but the more pressing need has been for an effective means of testing large numbers of men in a reasonable length of time. Four steps were suggested for improving the level of audiometry in the Services: 1. selecting the test most appropriate for yielding the information desired in a given situation; 2. establishing and maintaining standard test procedures; 3. providing standard equipment and adequate test rooms; 4. setting up a military specialty number for the personnel required by the testing programs. The Report of the Working Group on Military Audiometry specified that the most effective test for induction stations would be a screening type test and recommended the method developed by Dr. Glorig as being satisfactory for the needs of the Services. For the administration of full scale pure-tone audiometric tests to large numbers of men in the Service, the Report recommended that the Services experiment with some form of group audiometry that had already been developed, including automatic self-recording techniques.

Problems In Military Audiometry: A CHABA Symposium

6. Automatic Audiometry

John C. Webster

There seems to be some danger that the term automatic audiometry will come to be identified solely with one particular type of automatic audiometer. This is the type in which the subject, by his own responses, controls the intensity of the machine's output. Such an identification should not be allowed to occur, for there are many types of automatic audiometers.

Among the automatic audiometers now in operation are the following:

1. *The Békésy audiometer.* This has been in operation for several years in many laboratories and clinics. It is the typical 'patient-control-of-intensity' instrument. A graph of the crossing and recrossing of the subject's threshold is drawn by the machine as the frequency is slowly, but gradually increased. This graph has the disadvantage that it does not yield numbers directly, but must be interpreted.

2. *The Rudmose audiometer.* This is a patient-controlled machine, as the Békésy, which employs six discrete frequencies instead of continuously increasing frequency.

3. *The Brogan audiometer.* This patient-controlled machine, developed at the Air Force School of Aviation Medicine, is one in which the program and patient response is the same as the conventional clinical audiometer. The audiogram is typed on a sheet or punched on an IBM card.

4. *The Licklider audiometer.* This is a patient-controlled instrument in which the subject identifies in which half of a period of time the test tone was present.

5. *The Ward audiometer.* This is a pulsing-tone type of group audiometer developed at the Naval School of Aviation Medicine and the Central Institute for the Deaf. Ten men are tested at a time by the method of single descent, using a single attenuator.

6. *The Glorig audiometer.* Developed at the Speech and Audiology Center at Forest Glen under the combined auspices of the Army and the Veterans Administration, this machine presents tone pulses in groups, part of the pulses to one ear and part to the other. The subject must count the number of pulses in each group.

John C. Webster (Ph.D., Iowa, 1953) is a Resident Psychologist at the Navy Electronics Laboratory, San Diego, California.

7. *Navy audiometers.* Three of these have been developed, all more or less automatic, at the Submarine School in New London, the U. S. Navy Electronics Laboratory in San Diego and the Philadelphia Naval Hospital. In the first two, emphasis was on the group-test aspect and in the latter, automatic administration was the goal.

The audiometer that gives the lowest thresholds is not necessarily the best. Of greater importance is the reliability of the method, *i.e.*, its ability to give the same value on successive trials. The relation between the test values and the audiometric zero given in the American Standard can always be determined experimentally. A second important feature is the amount of maintenance or 'down time.' The original cost of the machine may also be a determining factor. A final, important consideration is how easily a malingerer can 'beat the game' with the machine.

After the objective of the audiometric testing has been determined and carefully specified, a selection should be made between group testing in a large, semi-partitioned room and testing in separate booths. In designing the machine, the subjects to be tested must be considered from the point of view of human engineering. In order to get the full cooperation of the subjects, the machine must be quite easy to operate. It must also be sufficiently reliable to remain in calibration and operate with a minimum of technical servicing.

If more than 40 men are to be tested at a time, group tests with scored sheets are probably the method of choice. For between 10 and 40, some other type of group audiometer, possibly the Ward type modified to print the results on a sheet or tape, may prove to be the best compromise. For 10 subjects or less, successive testing with individual instruments such as the Brogan or Rudmose may allow the procedure to be made more completely automatic and still more economical.

Summary

This paper has reviewed the problems presented by automatic audiometry and listed those automatic machines that were developed by late 1955. It stated that the object for which the audiometric examination is given must first be carefully determined and specified. When this has been done, a choice can then be made between individual and group audiometry. Where large groups of men must be tested quickly, some form of group test will have to be selected. Where less than 10 must be tested at a time, one of the individual types will probably be the best choice. Other important aspects included the amount of maintenance the machine will need and whether or not a malingerer can 'beat the game.'

Problems In Military Audiometry: A CHABA Symposium

7. Practical Limitations In Military Audiometry

Aram Glorig

There are three important limitations to good audiometry in the Armed Forces: personnel, equipment and test environment. However, these limitations might be eliminated by: (1) establishing a military specialty number for audiologists and audiometrists; (2) establishing centralized audiometer maintenance laboratories manned by civilian technicians in two or three strategically located cities; (3) issuing standard plans for constructing or purchasing sound-treated test rooms.

If the Armed Forces are to initiate and maintain even a peace time hearing testing and conservation program, problems of the assignment and continuity of technically trained personnel must be solved. This can be done by establishing a special classification for all men with training in audiology. Audiologists should, however, be distinguished from audiometrists. The first will be needed wherever advanced diagnosis and testing are to be performed and the latter will serve at induction stations, boot camps, reception centers and various Department of Defense industrial plants. Pre-induction, pre-placement and follow-up audiometry require only air conducting testing which can be done by an audiometrist who has less training than an audiologist. Both must be classified as specialists, however, and given different specialty numbers. Classification must be done for their own protection once they have been trained. At present, such specialty numbers do not exist and many men who are trained in this field are unable to practice their professions while they are in service. Unfortunately, their training also makes them useful in other lines of work and they are usually assigned to these less important tasks.

The maintenance of audiometric equipment is not something that can be done haphazardly or by any repair man. Adequate centralized facilities must be established and properly manned with civilian technicians. Civilian personnel should be utilized in lieu of military personnel on the grounds of better motivation and continuity of employment. In addition, these laboratories should be monitored by expert civilian consultants.

Perhaps the key limitation to good audiometry in the Armed Forces is the environment in which the audiometric tests are conducted. If the proper environment is not available,

Aram Glorig (M.D., College of Medical Evangelists, 1938) is the Director of the Research Center of the Subcommittee on Noise in Industry, which is a subcommittee of the Committee on Conservation of Hearing of the American Academy of Otolaryngology and Opthalmology. He is a former Army Representative on the CHABA Executive Council.

full compliance with the other requirements for good audiometry is meaningless. A standard must be drawn up for the construction of audiometric rooms in both extant and new buildings. The standard should also permit the use of prefabricated rooms. Standard plans for these rooms would ensure adequate sound reduction and good test environments.

Summary

Personnel, equipment and the test environment are the most important limitations in military audiometry. These could best be offset by establishing military specialty numbers for audiologists and audiometrists so that they may be retained in their jobs once they are trained. Central maintenance laboratories for audiometers, staffed by civil service personnel and monitored by expert civilian consultants, should be established in order to achieve technical continuity and accuracy in maintenance. Finally, standard plans should be devised to cover the construction of sound treated test rooms or their purchase as prefabricated units.

Problems In Military Audiometry: A CHABA Symposium

8. Audiometry In The Armed Forces

The CHABA Council

The Council is keenly interested in the further development and standardization of audiometry of all kinds for the benefit of the Armed Forces. The Council believes that the requirements for audiometers and audiometry should now be reviewed broadly in the light of the principles set forth at the CHABA meeting in October 1955.

Purposes and Objectives of Audiometry

The purposes and objectives of audiometry in the Armed Forces, including their civilian employees, fall into five major categories:

1. to select or reject men as a part of the regular initial physical examination;
2. to provide information for the otologist concerning the extent and nature, the probable cause, and the progress of individual hearing losses in relation to the disease and to the effectiveness of treatment and preventive measures;
3. to establish the amount of hearing loss for compensation purposes, including the determination of the original state of hearing before any service-connected or employment-connected hearing loss has developed;
4. to enable personnel officers to determine whether certain individuals are qualified for certain military specialties that involve special kinds of hearing ability;
5. to obtain new information as to (a) the causes and the prevention of hearing loss; (b) criteria for hazards to hearing; and (c) the effectiveness of particular tests and instruments for accomplishing the above objectives.

A clear distinction must be made between: (1) the kind of hearing test; (2) the way in which the test is administered; and (3) the particular instrument or technical means that embodies both the chosen test and the chosen method of administration. Not all types of hearing test will suit all of these purposes equally well. There is at the present time no single 'best' test of hearing, and much less is there any single 'best' instrument for adminis-

To assist in defining the unresolved issues related to audiometry and audiometers, the Council requested the Executive Secretary of CHABA (Hallowell Davis) to prepare a summary statement of the Purposes and Objectives of Audiometry and also to make certain recommendations in regard to the testing of hearing in the Armed Forces. The statement as presented here is an official expression of opinion by the CHABA Council.

tering hearing tests in all situations. The kind of test best suited for each purpose will depend upon the kind of information that must be obtained from the test.

For example, the most generally useful kind of hearing test is pure-tone threshold audiometry by air conduction. This was developed originally for diagnostic medical purposes and is also well suited for screening at induction centers, for monitoring hearing conservation programs, for estimating disablement and appropriate compensation, and for many types of medical research. Another kind of hearing test is speech audiometry, including tests of ability to hear speech in noise. These special tests are appropriate for determining special hearing abilities needed in particular military specialties.

It is assumed that a pure-tone test of hearing is desired. There are a number of ways in which pure-tone tests can be administered, each with its advantages and disadvantages. Furthermore, the different choices are not all mutually exclusive, but can be combined in many ways, just as an aircraft can be designed for combat, transport or reconnaissance, may be large or small, may be piloted or a robot drone, and may be powered by reciprocating, jet or turbo-prop engines.

Among methods and types of pure-tone audiometry there are major choices that must be made between: (1) screening audiometry *vs.* monitoring audiometry *vs.* diagnostic audiometry, which implies a choice between a pass-fail test, a limited audiogram, or medically-oriented audiometry including complete audiograms; (2) individual audiometry *vs.* group audiometry; and (3) manual *vs.* semi-automatic or fully automatic audiometry.

As to the means of embodying the chosen type and method in an actual instrument there are several choices at the engineering level, such as between electronic oscillators *vs.* tests recorded on discs or magnetic tape. The various choices listed above are more or less independent but, just as in the cases of aircraft, certain useful combinations are already well established. Audiometry was developed as a medical tool to assist in diagnosis and for this purpose the complete audiogram individually administered is universally employed. Furthermore, nearly all audiometers for diagnostic audiometry are manually operated and contain electronic oscillators. Semi-automatic recording audiometers for diagnostic purposes are under development, however, and may soon prove to be a useful supplementary tool in certain situations. The medical interest in diagnostic audiometry seems to lie in the development of new audiometric tests, rather than in new ways to facilitate the administration of pure-tone threshold audiometry.

For audiometry, as for aircraft, the choice of purpose is primary and the way of accomplishing the purpose depends on a balance of many factors, which include expense, personnel, and the availability of a particular instrument of established merit. The development of a means or instrument may make feasible a method that was previously not possible or practical. Such development is often an essential step, but a careful review of both old methods and new developments is mandatory before commitment is made on a large scale. There have been important recent developments in pure-tone audiometry for survey, monitoring, compensation and particularly for screening purposes. Such large scale audiometry as is obviously required by the Armed Forces should be

greatly facilitated by such new methods and instruments for group and individual pure-tone audiometry, both automatic and semi-automatic.

New methods and instruments alone will not insure good audiometry. Three other requirements are absolutely essential for *all* forms of audiometry. They are: (1) adequate acoustic environment, which means specially soundproofed, properly located booths and/or rooms to house the instruments and subjects; (2) trained personnel to administer the tests or to service any automatic devices that may replace the trained audiometrist; and (3) provision, both instrumentally and administratively, for periodic verification of the accuracy of audiometers in the field.

The uncertainties as to what are the best methods of audiometry for the Armed Forces appear to arise from the interplay of several factors. The most important factor is the recent laudable trend toward pure-tone audiometry as a required test of hearing to replace the out-moded voice and coin-click tests. The trend establishes a demand for audiometry on a large scale, but for audiometry that is quite different from the elaborate diagnostic audiometry that has for some time been employed as an adjunct to a medical specialty. Yet the concepts and the instruments for audiometry were developed for just these medical diagnostic purposes.

More recently screening audiometry, and group audiometry as a way of performing such screening, has been developed. Screening audiometry arose as a part of preventive medicine with particular orientation to the conservation of hearing in school children. The objective here was to identify rapidly those children who require closer examination and perhaps medical treatment. Such audiometry is roughly equivalent to the old voice tests and it has been rather taken for granted that it is the most appropriate type of audiometry for induction centers where a quick pass-or-fail test of hearing adequacy is the primary requirement. Screening audiometry, like diagnostic audiometry, is now a familiar and well established concept.

An intermediate type of audiometry that we here term 'monitoring audiometry' has more recently been developed in connection with conservation of hearing programs in industry. Its objectives are two-fold. One is to establish the state of hearing of a relatively large number of individuals to provide reference audiograms from which subsequent changes in their hearing are measured. The reference audiograms, particularly if they are pre-employment or so-called pre-placement audiograms, may be used to determine subsequent liability for later changes in hearing in connection with workmen's compensation. Its other objective is to detect changes in the hearing of individuals, relative to their reference audiograms before the hearing losses becomes a practical handicap. Monitoring audiometry thus gives warning in time for instituting effective protective measures, such as the reduction of the noise itself, the reduction of the noise exposure of the individual or the use of individual protective measures.

Monitoring audiometry is more restricted than diagnostic audiometry. Only air-conduction tests are required for monitoring audiometry and a more restricted range of frequencies and intensities are sufficient. It differs from screening audiometry, however, in that it must measure auditory acuity

and not merely give a pass-or-fail result. Usually, within the range that it covers, it must yield an audiogram comparable in accuracy with a diagnostic audiogram. The restricted range of a monitoring audiometer favors the development of group and of automatic or semi-automatic methods of administration. On the other hand, the necessity for accuracy and for an audiogram that is complete within the chosen range imposes serious difficulties both in the design of automatic instruments (particularly automatic group instruments) and in insuring their continued accuracy.

It seems clear that at present it is feasible to design and develop screening audiometers and monitoring audiometers that will expedite and make practical the screening and/or the monitoring of large numbers of individuals within reasonable limits of time, expense, space and trained personnel. It is not clear, however, that the same instrument should be expected to perform both functions. It is also possible that all monitoring audiometry need not be done in just the same way. In some situations an automatic individual audiometer, in other situations a manually operated group audiometer may have clear and overriding practical advantages. The general concepts of screening, monitoring, and diagnostic audiometry are well established, but there are several audiometric tests that fall in each class. There are various means or instruments for administering a given test and these differ in respect to expense, space, time and personnel required.

Recommendations

1. As the first step, if additional audiometry that seems to call for new methods or instruments is desired, a series of clear decisions as to the objectives and also the necessary limitations is required. Is it to be pass-fail screening audiometry or is it to be some variety of monitoring audiometry, or are both desired? In any case, what standards of accuracy are essential? If it is screening audiometry, at what level or levels is the screening to be done? If it is monitoring audiometry, what ranges of frequency and of intensity must be covered?

2. If a development is to be undertaken, there should be broad estimates as to how large the demand for such audiometry is likely to be as well as its urgency so that reasonable decisions can be reached both as to the type of instrument or instruments best suited to the task and as to the limits of time and money that might properly be devoted to their development.

3. The next step is to prepare a set of more detailed requirements for an instrument of the chosen type. These would include such points as the frequencies to be employed and the intensity range and steps, the form of psychophysical test to be employed, the limits of accuracy required, the size of the group to be tested, the form of scoring, the degree of participation by the tester, *etc.* These should be in the nature of performance specifications, without specifying the particular technical means by which the performance is to be achieved. Desirable features which might, however, be subject to some compromise, such as simplicity of operation, ruggedness, *etc.*, are difficult to express quantitatively, but can be clearly indicated in general terms. For example, the number of days that a development model of an automatic instrument must function without failure could be specified in advance. It should be possible in the present

state of art to frame such a set of performance specifications.

4. The next step would be to submit these specifications to qualified engineering firms for bids on the building of experimental models of proposed audiometers.

5. Experimental instruments of one, or preferably more than one, kind should then be built on development contracts.

6. These experimental models should then be given field trials. The testing should be carried out by groups other than those primarily responsible for the design and/or construction.

7. On the basis of such field trials an instrument or instruments might be adopted for standardization and manufacture. Presumably at this stage, on the basis of experience gained in the trials, the performance requirements could be modified to take advantage of what then appears to be the best compromise between desirable ideals and technical, economic or administrative limitations. If the modifications made in the light of experience are considerable, further experimental instruments might be developed and tested.

Summary

'Audiometry in the Armed Forces' was prepared by the CHABA Council as an official statement concerning the status of audiometry in the military services as of the year 1955. The purposes and objectives of military audiometry are reviewed and the various kinds of audiometry are discussed. The Council recommends the administration of pure-tone audiometry by a rapid means so that the hearing of personnel can be checked easily, or 'monitored,' as a routine procedure. Monitoring Audiometry is the new term introduced to designate this intermediate form which is more elaborate than screening but less elaborate than diagnostic audiometry. It has evolved in industrial hearing conservation programs, but can be easily adapted to the needs of the Armed Services.

After certain basic decisions are reached by the Services regarding the audiometric standards that their personnel must meet, specifications can be developed for experimental monitoring audiometers.

Noise Bands *vs.* Pure Tones As Stimuli For Audiometry

Cecil K. Myers

One assumption behind the use of octave or semi-octave steps in discrete-frequency audiometry is that each frequency serves only to sample acuity at all intermediate frequencies. But the sampling may or may not be thorough, especially with octave steps, where considerable detail can be lost if acuity at intermediate frequencies exhibits sharp disparity. The increasingly prevalent use of the Bekesy-type audiometer attests to the desire of audiologists to put the intermediate frequencies under scrutiny. This procedure is, however, expensive both in time and apparatus. If a substitute or compromise solution could be found, some benefit might result.

It seemed possible that a somewhat better sampling of acuity in a frequency region could be obtained if, instead of presenting a single tone selected from the middle of that region, one presented a band of noise taken directly from that region. Acuity for the band of noise could be assumed to represent a sort of average of the acuities for all the separate frequencies contained within the band.

If a patient has a sharp dip at one of the discrete frequencies, tests with a noise band might better summate the acuities in that frequency region. Thus, a noise band around the dip might provide a better measure of the patient's ability to handle auditory cues in that frequency region.

Other considerations led to the question of whether noise bands could replace pure tones in audiometry. It seemed possible that test-retest reliability of noise-band audiometry might be superior, since the influence of standing waves in the earphone-eardrum coupling would be minimized. Also, fluctuations from frequency to frequency of both acoustic impedance and of earphone frequency-characteristic would tend to be smoothed out. Moreover, from the patient's point of view, the identification of the stimulus might be simpler and involve less learning than the detection of pure tones; in some cases a noise band might be easier to distinguish from pure-tone tinnitus.

Cecil K. Myers (B.S., Geneva College, 1934) is Chief Audiometrist in the Sound Branch of the U. S. Naval Medical Research Laboratory, New London, Connecticut.

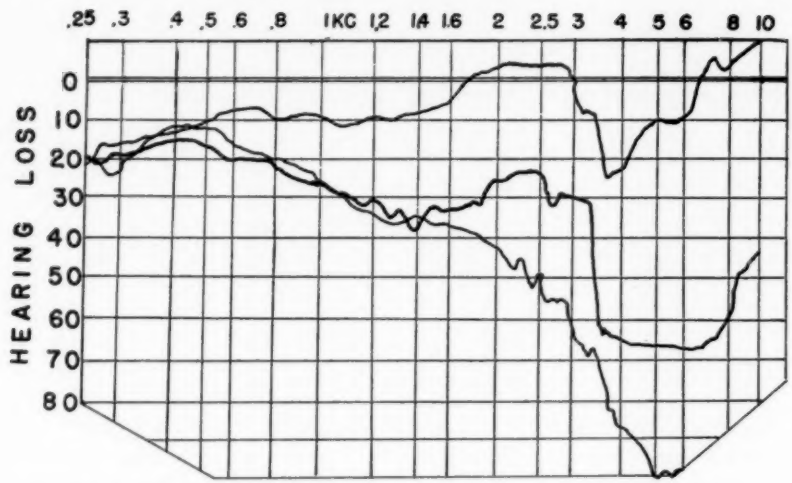

FIGURE 1. Bekesy audiograms of three typical subjects.

This article is concerned with the construction of a phonograph disc containing noise bands, and with the efficiency of noise bands *vs* pure tones in general audiometry.

Apparatus. White noise was led through two Allison continuously-variable filters coupled in series, and put on an LP disc with an RCA cutter. A band of noise was created by adjusting the filters until the desired frequency region was obtained as seen on the Panoramic Sonic Analyzer. Lands and grooves on the disc gave the operator the choice of any of the following bands: 400 – 630 c/s, 800 – 1250 c/s, 1500 – 2500 c/s, or 3200 – 5000 c/s.

The playback output was led through two attenuators, each with 10 db and 1 db steps, in series, to a Permoflux PDR-8 earphone in an MX-41/AR cushion. A manual switch located before the attenuators allowed the subject to interrupt the noise at will. Level of stimulus at threshold was recorded in relative terms only, with a voltmeter at the phone terminals and a calibrating 1000 c/s tone on the disc. A Sonotone audiometer was also led to the manual switch and attenuators; level of stimulus at threshold was measured as before. All impedances were matched.

Subjects

Twelve subjects, 11-62 years of age, were selected. All had discontinuities in acuity through one or more of the frequency regions being studied, as revealed by both a descrete-frequency and a full Bekesy audiogram. Figure 1 gives the Bekesy audiograms of three typical subjects.

Procedure

Subjects were asked to adjust one of the attenuators, using the inter-

TABLE 1. Relation between acuity for pure tones and acuity for bands of noise.

Pure Tone (c/s)	*Noise Band* (c/s)	*Correlation* (*Rho*)
500	400—630	.92
1000	800—1250	.94
2000	1500—2500	.81
4000	3200—5000	.75

rupter switch at will, until they could just hear the tone, or noise, about half the time. (The tester changed the other attenuator to reduce position cues on successive adjustments.) Ten such adjustments were made with each stimulus. Frequency regions, noise, and tones were suitably counterbalanced for all subjects to minimize learning, fatigue, *etc.*

Results

The correlation between acuities for the two stimuli was examined to see whether the same thing was being measured. The rank-order correlations between several bands of noise and the pure tone centered in each band are shown in Table 1. It seems possible that for the lower frequency regions the two types of stimuli are, for all practical purposes, interchangeable, but that for the higher regions, the two measurements are different.

The next question was whether the variability of the subject's response was greater or less with one stimulus than with the other. The standard deviation of each set of 10 adjustments was computed. A slight tendency appeared for the noise stimulus to have a smaller variance at the two lower frequencies. The ranges of standard deviations for the two stimuli overlapped almost completely. At the two higher frequencies, the variances showed no difference at all.

For the purpose of evaluating test-retest reliability, results of the first five adjustments were compared with results of the last five adjustments for each of the four discrete frequencies and for each of the four noise bands. Absolute mean differences between corresponding sets of measures ranged from 1.2 to 1.5 db for the four pure tones and from 1.2 to 1.6 db for the four noise bands. When direction of difference, that is, increase or decrease of acuity from the first five to the second five adjustments, was taken into account, the mean differences were in the direction of slightly increased acuity for the last five adjustments. These differences ranged from 0.2 to 1.0 db for the four pure tone and from 0.3 to 1.0 db for the four noise bands. Since the differences are small, not much advantage is to be gained by employing ten adjustments rather than five.

Patients were asked whether they preferred listening for tones or noise-bands. Seven expressed a preference for noise, three for tones, two undecided. No patient had a strong preference.

Discussion

The results obtained showed that no advantage was gained by changing to noise bands. However, there may be situations where some particular region needs to be sampled with special care and a Bekesy audiometer may not be available. Here the relation between noise-bands and pure tones may fill out an otherwise less complete picture. Furthermore, not only would a disc of noise-bands (with each band centered on a conventional audiometric frequency) be useful as a stimulus in certain situations, but also the disc would be useful as a source of masking noise in both air-

conduction and bone conduction audiometry. These narrow bands of noise have been found to be a nearly ideal masking stimulus in the writer's laboratory. The disc is a handy source of a masking noise which is maximally efficient, yet lacks the annoying loudness of unwanted frequencies. If properly calibrated on normal ears, the disc could substitute completely for a pure tone audiometer.

Summary

A group of twelve patients with partially defective hearing was examined with tones of 500, 1000, 2000, and 4000 c/s and also with bands of noise centered at those same frequencies. No important advantage in variability or test-retest reliability was observed for either type of stimulus. The correlation between the two measures decreased slightly with higher frequencies. Thus it is suggested that, if a Bekesy audiometer is not available to examine patients with high-tone losses, testing with a phonograph disc containing one or more narrow bands of noise might add more information to that yielded by discrete-frequency audiometry.

The C. S. Bluemel Collection On Stuttering

Elwood Murray

In 1940 Dr. C. S. Bluemel donated his library on stuttering to the University of Denver. The books were collected from many countries over a period of many years. Most of them are now out-of-print. The C. S. Bluemel collection of Books on Stuttering is housed in the Mary Reed Memorial Library at the University of Denver. The books are available on interlibrary loan or for microfilming to workers in the field of speech pathology and correction.

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Use of Palatography

Peter Ladefoged

In recent years workers in the field of speech have become greatly in need of more precise data concerning the articulation of speech sounds. The present need has arisen partly because of the increased detail with which languages are now described, and partly because many research workers are currently trying to correlate the traditional articulatory descriptions of speech with the results of the new forms of acoustic analysis. A most convenient way of arriving at articulatory data is by means of palatography, which is a method for locating the points of contact between the tongue and the roof of the mouth. From these data it is possible to deduce some of the probable variations in the shapes of the vocal cavities during an utterance.

Systems of Palatography

In one of the modern forms of palatography (*2*), the subject first sprays a black powder on the upper teeth and the roof of the mouth (including both the hard and the soft palate), and then says the word or phrase to be investigated. Wherever the tongue touches any of the areas which have been sprayed, the black powder is removed. It is possible to see and photograph these areas with the aid of the apparatus shown in Figure 1. With the mouth placed over Mirror A, the subject can see in Mirror B the velum, the hard palate, the alveolar ridge, and the upper teeth; consequently he can observe where there has been articulatory contact. In addition, a permanent record can be made by photographing the contact areas with the camera behind Mirror B. This technique, which is known as direct palatography (*1*), was used to produce the palatograms which illustrate this article.

Another system of palatography involves the use of a specially made artificial palate which is dusted with a marking medium before being put into the mouth. After the word to be investigated has been pronounced, the palate may be removed, and a note made of the regions in which the marking medium has been wiped away. It is also possible to draw or photograph the false palate if a permanent record is desired (*5*).

There are several points to be considered when comparing these two methods of palatography. First, the direct method has the advantage that it makes it possible to study the articulations of a large number of speakers without a great deal of preparation. The making of a good artificial palate is a skilled, lengthy process, which cannot be readily undertaken for hundreds of subjects; much of the information derived from

Peter Ladefoged (M.A., Edinburgh, 1951) is a lecturer in the University of Edinburgh Phonetics Department. He is in charge of the departmental laboratory.

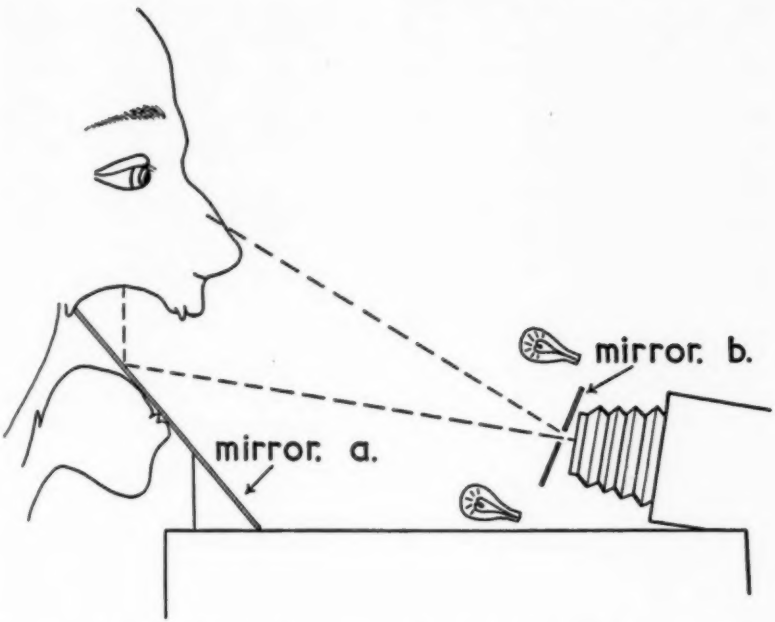

FIGURE 1. Schematic diagram of the apparatus for direct palatography.

palatographic investigations using false palates is of only limited value, because it has been based on the study of a few individuals, whose articulations may not be typical.

A second advantage of the direct method is that it need not affect the normal articulation of a sound; whereas even the finest false palate slightly alters the shape of the vocal cavities, and hence may have some effect on the action of the articulators.

Finally, the direct method enables us to study a far wider range of articulations. False palates can be made with flexible portions so that some articulations on the soft palate can be recorded; but this is not entirely satisfactory. Using the direct method it is possible to observe articulatory contacts anywhere between the tips of the frontal incisors and the uvula.

One reported difficulty (*10*) with direct palatography (actually using a system slightly different from that described here) is that there may be a variation in the angle from which the photograph is taken. However, this apparent disadvantage of the system can be overcome by maintaining the camera and the mirror in a fixed relation, and ensuring that every subject places his head so that his palate is in the same position. It has also been said of direct palatography that 'because of the angle of the mirrors, prints of the palate show it slightly elongated' (*2*). But it has now been found that it is perfectly possible to arrange the mirrors so that the

camera viewpoint is effectively at right angles to the plane of the teeth, thus preserving the ratio between the width and the length of the palate. If the positions of the camera and Mirror A are as shown in Figure 1, the required view is obtained when the subject places his mouth over the mirror in such a way that the plane of his teeth is horizontal. The only practical difficulty is in deciding what is meant by 'the plane of the teeth' for subjects with irregular dentition.

Articulatory Positions

Whichever system of palatography is used, the results of a palatographic investigation will be articulatory data in the form of diagrams or photographs which can be archived or published. But any diagram or photograph of the palate is a two dimensional representation of information which was originally in three dimensions. A view of the palate from a point at right angles to the dental plane (which is the traditional way of presenting a palatogram) preserves the ratio between the length and the width of the palate only at the expense of giving an inadequate impression of the depth of the palate. As a result, palatograms often fail to convey important information concerning the shape and depth of the palatal cavity, and the position and slope of the alveolar ridge.

One answer to this problem is to use stereoscopic photographs. Another, which is more convenient if the data are to be published, is to accompany each palatogram with a diagram showing a sagittal section of the palate. The simplest way in which this can be obtained is by sawing along the mid-line of a cast of the mouth. Such a diagram will be inaccurate in so far as it fails to take into account the movements of the soft palate which may be important in speech (2). But it will give a satisfactory outline of many of the important features of the roof of the mouth.

When the shape of the roof of the mouth is known, it is also often possible to deduce the probable shape of the tongue during the articulation of the consonant in an utterance. After gaining experience with palatography, the information necessary for making a very approximate diagram of the presumed position of the tongue may be obtained by comparing a palatogram with a cast of the roof of the mouth. In order to facilitate the transfer of more precise data about the positions of the tongue from the palatograms to the sectional diagrams, a contour map of the palate has to be prepared. The contours of the palate can be obtained by cutting a number of sections of a cast in the plane parallel to the dental plane, each section being at a regular distance from a fixed point such as the point on the roof of the mouth furthest from the dental plane (*i.e.*, the deepest point of the palate). When an extensive palatographic study of a particular speaker is being made, contour lines obtained in this way can be drawn on a transparent overlay which can be placed on any photograph that has been enlarged to natural size. Thus, information concerning the height of the tongue may be speedily transferred onto the sectional diagram.

Figure 2, which shows a palatogram of the author's pronunciation of *eke*, illustrates the use of this technique. Contour lines at 0.2″ intervals have been superimposed on the palatogram, and corresponding lines have been drawn across the sectional diagram.

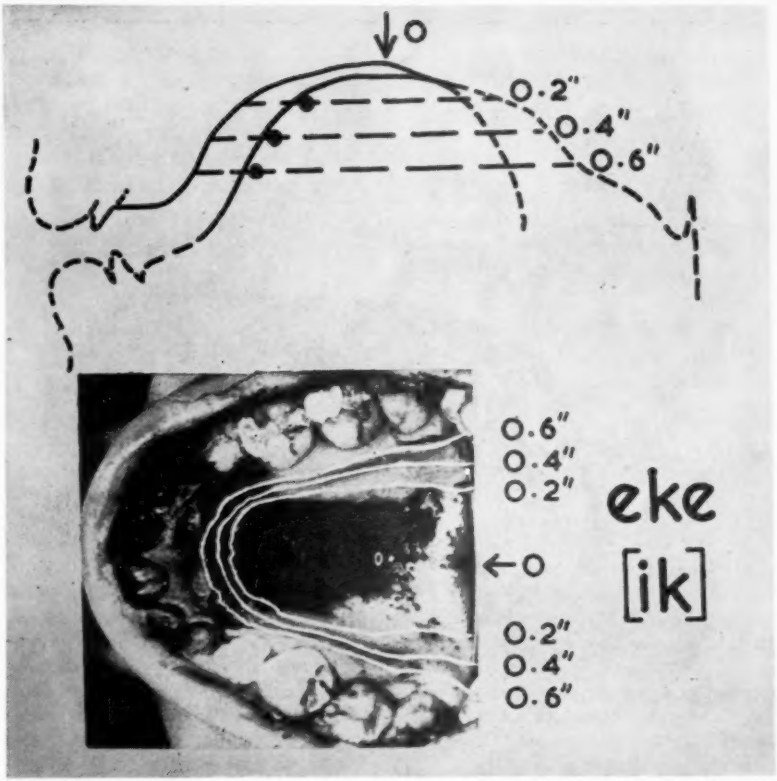

FIGURE 2. Palatogram of *eke* [ik], with superimposed contour lines at 0.2" intervals.

In this particular utterance it is probably fair to assume that most of the powder is wiped off during the articulation of the consonant. (A subsequent section of this article presents confirmatory evidence from X-ray photographs, which indicate that the body of the tongue retains an approximation to the vowel position during part of the consonant closure.) Hence the limits of the contact areas indicate the positions of the sides of the tongue at a specific moment. It can be seen from the palatogram that the sides of the tongue have removed a considerable amount of the marking medium from the hard palate. The extent of the raising of the body of the tongue is indicated fairly accurately on the sectional diagram. The means of the points at which the sides of the tongue cross each contour line are marked by small dots; and then, on the assumption that in this utterance a cross section of the tongue would show that it is slightly domed,

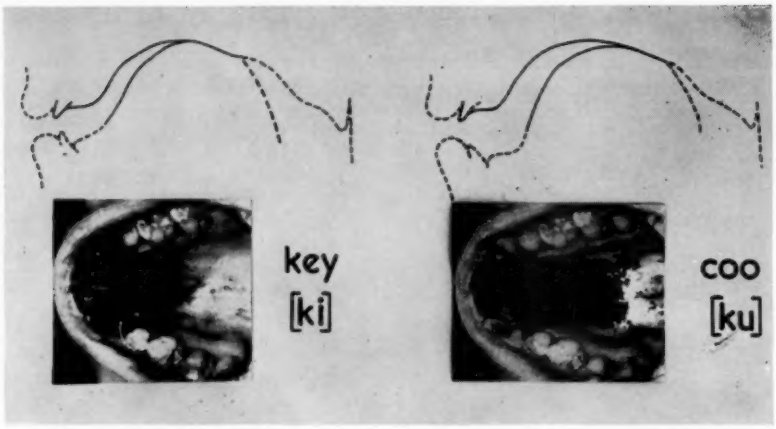

FIGURE 3. Palatograms of *key* [ki] and *coo* [ku].

the presumed position of the centre of the tongue is indicated by a line slightly above the dotted positions. In this, and in all the other diagrams accompanying the palatograms illustrating this article, positions of the vocal organs which cannot be deduced from palatographic data are indicated by dashed lines.

Selection of Utterances

In most phonetic investigations it is advisable to make palatograms showing the effect of pronouncing whole words. The resulting photograph is then a composite representation of a series of articulatory positions; but this is preferable to the artificial procedure of attempting to obtain a record of an isolated speech sound. There is always an interaction between the consecutive articulations of an utterance. Figure 3 illustrates the well known difference in the place of articulation of the plosives in *key* and *coo*. The articulatory contact is clearly much further forward when the velar plosive is followed by a front vowel as in *key*. A further point of interest arises from a comparison of Figures 2 and 3, which indicates that the plosive in *eke* is not articulated in the same place as either the plosive in *key* or that in *coo*. The very advanced variety of velar plosive occurs only when it is the initial consonant in the syllable.

Figure 4 shows that there is a similar variation in the initial plosives in the words *tea* and *two*. The articulatory contact behind the frontal incisors is slightly further back when the plosive is followed by a back vowel. In view of all these differences it would seem that there is little point in trying to investigate the articulation of isolated segments of speech. Probably the most convenient way of considering a palatogram is as an aid in abstracting the articulatory features which characterize an utterance as a whole (*4*).

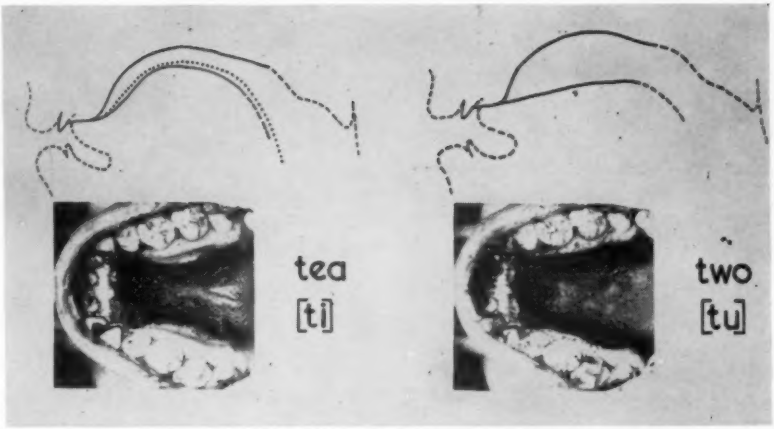

FIGURE 4. Palatograms of *tea* [ti] and *two* [tu]. The dotted line indicates the position of the centre of the tongue as shown on an X-ray photograph taken during the consonant closure in *tea*.

Comparison with X-ray Data

The articulatory features indicated in the sectional diagrams accompanying the palatograms in Figures 2-6 may be incorrect because there are two assumptions underlying the deduction of the positions of the tongue. First, it is presumed that in these utterances most of the powder was removed during the articulation of the consonant; and second, the height of the centre of the tongue is presumed to be not very different from that of the sides. As a check on these assumptions, X-ray photographs have been taken of the positions of the articulators during the author's pronunciation of the consonants in some of these words. A thin line of barium sulphate was painted on the centre of the tongue so that its position was clearly marked on the photograph.

In most of the utterances, there is a high degree of agreement between the diagrams of the position of the centre of the tongue as deduced from palatograms and as shown on the X-rays. This agreement is illustrated in Figure 4 where the dotted line indicates the position of the centre of the tongue as recorded on an X-ray photograph taken during the articulation of the consonant at the beginning of the word *tea*. In this case, as in others, the X-ray photograph shows that even during the consonant closure the body of the tongue is approximating towards the position for the adjacent vowel.

Only occasionally do X-rays reveal major differences between the positions of the centre and sides of the tongue. These differences are of greatest importance in the study of fricatives. Thus, the articulation of [s] as in *saw* in the author's speech is as shown in Figure 5. The continuous line indicates the position of the sides of the tongue as shown by the limits of the contact areas in the

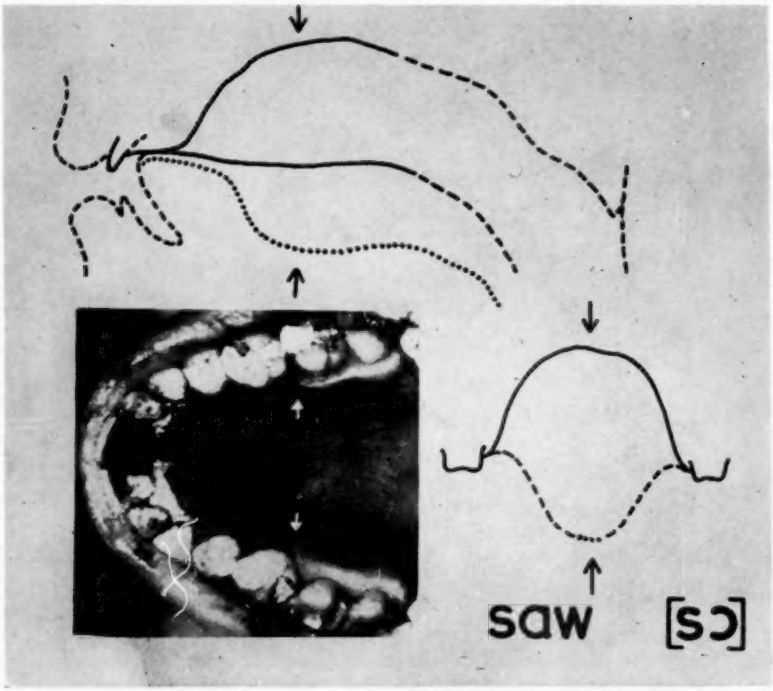

FIGURE 5. Palatogram of *saw* [sɔ]. The dotted line indicates the position of the centre of the tongue as shown on an X-ray photograph taken during the consonant closure.

palatogram (which are unlikely to be due to the vowel in this word) and the dotted line represents the data obtained from an X-ray photograph showing the position of the centre of the tongue during the fricative. These positions are typical of the author's pronunciation (which is a form of the English of England known as R.P. (7), with no marked idiosyncratic features); palatograms and X-rays showing similar positions have been obtained on a number of occasions.

It is obvious that during the author's pronunciation of the fricative [s] followed by the back vowel [ɔ] there must be a very deep hollow in the tongue. The extent of this hollow can be seen more clearly in the transverse section of the mouth shown alongside the palatogram. This section is taken along the line joining the second molars, as shown by the arrows. Only the dashed line in this diagram indicates a presumed position; the outline of the roof of the mouth is accurately known from a section of a cast; the position of the sides of the tongue can be deduced from the palatogram; and the dotted line indicating the position of the centre of the tongue de-

pends on data obtained from an X-ray photograph. This diagram is a good illustration of the way in which palatographic and X-ray evidence supplement one another. In the examination of many sounds, the two techniques are not mutually substitutable but are complementary, each providing data which are not revealed by the other.

Description of Articulations

The data which result from a palatographic (or from an X-ray) investigation are records of different articulations. The description and comparison of such data is one of the most challenging problems of articulatory phonetics. There are two aspects to this problem: one involving the comparison of various utterances by the same speaker; and the other the comparison of the articulations of a number of different speakers.

In practice the first of these problems is relatively simple. Provided the photographs have all been taken from the same angle, and enlarged to the same size, articulations may be compared by direct reference to the palatograms, as in this article. When specific points are being singled out, an *ad hoc* reference system can be used. For example, in Figure 3 the contact in the centre of the velum during the pronunciation of the word *coo* [ku] can be said to be on the line joining the third molars; whereas that in *key* [ki] is on the line joining the second molars. Many systems of reference have been devised, most of them using the teeth as reference points (*4*, *8*, *10*). These systems are usually fairly satisfactory when comparing a number of palatograms of a single speaker with adequate dentition.

Several difficulties arise when we try to describe and compare the articulations of different speakers. Some of these difficulties are due to misconceptions concerning the nature of phonetic descriptions. A phonetician's description of an utterance is generally the result of a process which involves listening to the speaker (and sometimes looking at him as well) and then considering the speech sounds he has produced in terms of a number of phonetic categories which owe their existence partly to tradition and partly to the particular training which each phonetic observer undergoes. Only comparatively seldom does the phonetician base his descriptions on an examination of instrumental records of the articulations of a particular speaker; such an examination invariably reveals that it is difficult to interpret instrumental data in terms of the traditional phonetic categories.

Recently much attention has been devoted to this problem from the point of view of acoustic phonetics. It is well known that it is difficult to determine the precise quality of a given vowel simply by inspection of a spectrogram which shows its acoustic characteristics. The position of the formants will give an indication of the approximate phonetic quality of the vowel; but acoustic data of this sort will not show whether a phonetician would consider it to be closer to one cardinal vowel rather than another.

It is less well known that there are similar problems in the field of articulatory phonetics. Nevertheless, difficulties have been reported by workers who have tried to correlate the traditional descriptions used in the classification of speech sounds with a mass of data obtained from palatography (*10*) or from X-ray photography (*6*). These difficulties are due to the present use of the traditional phonetic

FIGURE 6. A palatogram of *key* [*ki*] as pronounced by a second subject.

categories, most of which originated as partial physiological descriptions. In recent years many skilled observers have been listening to utterances and then making precise classifications of the sounds involved. As a result, several phonetic terms have come to be used not as descriptions of actual articulations, but as labels for the end products of an auditory investigation.

In addition, the number of phonetic categories has increased considerably. Thus, early nineteenth century phoneticians distinguished between dental, alveolar, palatal and velar sounds; nowadays some phoneticians distinguish between dental and interdental, pre-, mid- and post-variants of each of the categories alveolar, palatal and velar, and also variants of categories such as uvular and pharyngal. No doubt these small distinctions are necessary if we are to organize our phonetic material conveniently and accurately. But although it may be possible and useful to make such precise auditory distinctions, it is illusory to think that these distinctions reflect equally precise articulatory categories.

Some of these problems are illustrated by a comparison of the author's pronunciation of *key* (Figure 3) and that of another subject's pronunciation of the same word (Figure 6). An examination of these two palatograms does not reveal whether these two utterances are auditorily equivalent. But all the phoneticians who heard these utterances were in no doubt that both the articulations could be classified as being post-palatal. At the moment there is no scheme of reference which will enable this information to be extracted from the palatograms. Firth (*4*) has suggested using the teeth as reference points from which to determine articulatory zones. But a study of a large number of subjects has shown that there is insufficient correlation between the positions of specific teeth and the positions of anatomical features, (e.g., the alveolar ridge and the highest point of the palate) which are important in determining the acoustic quality of a speech sound. In addition, there are other difficulties involved in using the teeth as reference points: several teeth may be missing, and there may or may not be gaps between the teeth which remain; sometimes the teeth (particularly the incisors) overlap; and nearly always the posterior molars are not far enough back to provide adequate reference points on the soft palate. In a survey (*9*) of 50 members of Edinburgh University it was found that 40% had dentition of a kind that made it difficult to use the teeth as reference points.

An alternative scheme of reference is to divide the roof of the mouth into a number of anatomically defined sections. Thus, Jones (7) defines the teeth ridge as 'the part of the roof of the mouth just behind the teeth which is convex to the tongue, the division between the teeth ridge and the palate being defined as the place where the roof of the mouth ceases to be convex to the tongue and begins to be concave.' But definitions such as these are not easily applicable in practice. As part of a preliminary investigation (*9*) of this problem a number of experienced phoneticians were shown midline sections of the roofs of the mouth of four subjects, and were asked to indicate the extent of the alveolar ridge. There were several substantial divergencies (including differences of opinion concerning the division of the sectional diagrams used to illustrate this article). But these phoneticians are all in agreement when making auditory distinctions between small variations in alveolar sounds.

It would seem, therefore, that there is at the moment no adequate way of interpreting data about the positions of the vocal organs in terms of the phonetic categories which are used in the auditory investigation of speech. There are thus limitations on a palatographic investigation (which are, of course, equally applicable to all other forms of instrumental analysis of articulations). But palatography remains one of the most useful methods of obtaining information about articulatory positions, particularly in investigations involving the detailed study of the pronunciation of a single speaker. In addition, the articulations of different speakers may be investigated by comparing the relations between the articulations which occur during the pronunciation of a series of words by one speaker with the relations between the articulations which occur when the same set of words is pronounced by other speakers. Thus, a study of the pronunciation of the words *Tay*, *tray* and *jay* by 32 students at Edinburgh University showed that 21% made the plosive in *tray* further forward than that in *Tay*, and 18% made it more retracted; and only 6% made the contact for the plosive in *jay* appreciably further back than that in *Tay*. In another investigation a comparison of the pronunciation of the minimal pair *sip - ship* by 164 speakers has shown that for every speaker the articulation of the voiceless fricative in *sip* involves the formation of a narrower channel (which is usually also further forward) than that in *ship*. These studies of the relations between articulations are at the moment the most profitable way of comparing the articulations of similar sounds spoken by a number of different people.

Summary

A modern form of palatography has been reviewed in which a black powder is sprayed directly on the teeth and the hard and soft palate. Following an articulation a mirror is placed in the mouth in such a manner that a photograph can be made of the roof of the mouth, thus recording the articulatory areas in which the tongue made contact and removed the powder. Contour maps of the palate derived from casts and X-ray photographs may be employed to obtain further details about articulatory positions. From all these data it is possible to deduce some of the probable variations in the shapes of the vocal cavities during parts of an utterance. These experimental studies indicate, however, that it is difficult to correlate

physiological data about the positions of the vocal organs with the traditional phonetic categories which are used in most descriptions of speech.

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The American Speech and Hearing Association

THIRTY-FOURTH ANNUAL CONVENTION

November 17-19, 1958, Hotel New Yorker,
New York City

FORMAL CALL FOR PAPERS

An invitation is issued to all members of the Association to submit abstracts of papers which they wish to have considered for presentation on the program at the Annual Convention in 1958. Non-members are also invited to submit abstracts. General program ideas and suggestions are welcomed by the Program Committee. All communications, including abstracts, should be sent to Leo G. Doerfler, Department of Audiology, Eye and Ear Hospital, Pittsburgh 13, Pennsylvania.

The deadline for submission of abstracts is *April 15*, but members are urged to forward their proposals as far in advance of that date as possible. General program suggestions should be made immediately if they are to be of help to the Committee.

Abstracts must include (1) the full title of the proposed paper, (2) the name of the contributor and his professional affiliation, (3) the time required for the presentation, (4) details of any equipment needed for the presentation, and (5) a concise summary of the content of the paper. Excessively brief, incomplete, or otherwise inadequate abstracts cannot be considered; in general, abstracts should be one to two pages in length.

Submission of an abstract implies that a contributor accepts the following responsibilities: (1) He must be present in person at the scheduled time. If unforseen circumstances prevent his appearance, he must make suitable arrangements with his chairman as far in advance as possible. (2) He must keep strictly within the time limits assigned to him by his chairman.

Perusal of previous programs will inform prospective contributors of the wide range of possible topics suitable for consideration. They need not be confined to experimental studies, but may include theoretical and practical discussions of any phase of the speech and hearing processes or any aspect of human communication. It is hoped that a large number of abstracts and program ideas will be submitted; careful consideration will be given to all of them.

Individuals responsible for such functions as receptions, alumni luncheons, open houses, *etc.*, are invited to submit the essential information to the Program Chairman for inclusion in the Convention Program.

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Book Reviews

TEMPLIN, MILDRED C. *Certain Language Skills in Children.* Minneapolis: The University of Minnesota Press, 1957. Pp. 183. $4.00.

This is a long awaited volume, an important and welcome one. It represents a prodigious amount of patient and persistent labor. Speech people, especially therapists, will find it a useful instrument in the evaluation of the speech status of normal children.

The contents of the book are organized under five general headings. They are: the articulation of speech sounds, speech sound discrimination, verbalizations, vocabulary and the interrelationships among several language skills. This treatment is preceded by a chapter describing the experiment including the subjects, the language areas measured, the administration of the tests and the method of analyzing the data.

In the selection of the subjects, the aim was to provide normative data. To this end special efforts were made to control such factors as age, sex, intelligence, family constellation, language spoken at home, bilingualism, twinning, and defective hearing. There were 480 children, ranging in age from 3 to 8 years of age, as subjects. This total was made up of eight samples of 60 children each at 3, 3½, 4, 4½, 5, 6, 7 and 8 years. At each age level 30 were boys and 30 were girls. The children were enrolled in the Minneapolis and St. Paul public schools kindergartens and nursery schools. They were selected according to the fathers' occupational level as classified according to the Minnesota Occupational Scale. The children were given the Stanford-Binet Intelligence Test or the Ammons Full-Range Picture Vocabulary Test. When the latter was used the scores were converted into IQ-equivalents.

The articulation test consisted of 25 consonants, 5 diphthongs and a large number of double and triple consonant blends. The sound discrimination test included 50 pairs of nonsense syllables to be judged as 'same' or 'different' by the 6 to 8 year subjects. With the preschool children, 59 pairs of familiar objects whose names were words similar in pronunciation except for a single sound element were used. These two tests were devised by Templin herself. The vocabulary tests employed were the Seashore-Eckerson English Recognition Vocabulary Test and the Ammons Full-Range Picture Vocabulary Test. In order to study sentence development, 50 verbal utterances were obtained from each child and then analyzed for length of sentence, the different words, the parts of speech, the grammatical structure. Since this was a normative study, the data for each of the four language areas were presented in terms of central tendencies and standard deviations.

It is impossible in a short sketchy review to give a complete account of the amazing detail and the broad scope of this study. The reader will have to examine the book for himself to appreciate the extent of its coverage. However, since the materials of the research have been cast into the form of tests, it may be useful to examine how they were constructed. To illustrate this matter, attention will be confined here to the tests of articulation.

The construction of a standardized test in any research area is a highly technical undertaking and involves a number of problems and criteria. Among the problems are the following: (1) to what degree is the sample testees representative of the population? (2) what is the reliability of the examiner who transcribes the sounds? (3) what is the reliability of the test itself? (4) what is the range of difficulty of the items in the test? (5) is there an age progression in the scores? (6) what is the discriminating power of the items? (7) do the items possess the characteristic of uniqueness? (8) what is the validity of the test?

The task facing the reviewer is: How

Book Reviews is edited by Ernest H. Henrikson, University of Minnesota.

well does the Templin test measure up to these criteria of test construction? It is perhaps too much to demand of a given test that it meet every one of them, but an examination in these terms will help the speech therapist and the reader to evaluate the study and to appreciate the hard work which has gone into its construction.

The first criterion concerns the sampling of the subjects. The sample is an urban one and the proportion of cases in each socio-economic level was matched with the occupational distribution of the 1940 United States population, excepting the rural category.

The actual sample corresponded closely to the theoretical sample. This is all to the good. There is, however, in speech sampling a special problem. Different dialects are spoken in various areas throughout the United States. The present sample is restricted to the Minneapolis-St. Paul area. A more adequate sample would be nation-wide.

It is generally considered that a study stands or falls on the reliability of the observer who collects the data. The author of this test is an accomplished phonetician and her work consequently must have a considerable degree of reliability. But no effort was made to find out precisely what it is. Without it the over-all error in the data cannot be stated.

One of the most important criteria to be met in the construction of a standardized test is its internal consistency of the reliability of the test itself. Fortunately there is information available about this matter. The data are there but the actual determination of the reliability has not been made. Hoyt's formula for test reliability based on an analysis of variance easily could have been applied to the data.

The range of difficulty of the items of a test ordinarily should be from 10 or 15 percent to 85 or 90 percent. This problem is handled indirectly by Templin. In Appendix IV, Table 1, data for each of the eight age levels are given as frequencies. The highest score for an age is 60, the lowest is 25. Difficulty ranges in terms of percentages would be more meaningful. The reviewer converted the eight frequency ranges into percentage ranges. The difficulty ranges for the several ages averages out to about 10 per cent to 100 per cent. This is a little high.

In Appendix IV, Table 2, percentages of correct articulation are given with the 8 year old sample taken as a measure of terminal status. This affords information in its own right, but it is not ordinarily what is meant by percentage range of difficulty of the items of a test.

The problem of age progression in the scores is amply demonstrated in tables appearing throughout the book. The Templin articulation test meets this criterion with complete adequacy.

It is necessary in a standardized test that the items discriminate the individuals taking the test. For if all subjects, irrespective of their ability, get the same scores on an item, that item does not possess discriminating power. This factor is calculated by the correlation of the item score with that of the whole test and may readily be secured by means of Flanagan's table of product-moment correlations. High correlations are indicative of discriminating power. This problem appears to be unresolved in this test.

The uniqueness of items refers to the requirement that two items should not perform exactly the same function in a test. It is determined by calculating the intercorrelations among the items. These values should be relatively low and certainly much lower than the r's for discriminating power. The intercorrelations among the items is not reported in the book and consequently the uniqueness of the items remains unknown.

Finally, there remains the most important criterion of a test, namely, its validity. For, if there is fairly strong evidence for the validity of a test, there is perhaps presumptive evidence that the other criteria have been met in more or less adequate fashion.

There are several methods for the validation of a new test. One of them is to give it together with a generally accepted standardized test to the *same* group of testees and to correlate the two sets of scores. If the r is reasonably high, the new test may be considered to be validated. This was not done in the Templin work. On the other hand, rather careful comparisons were made with the results of similar studies such as those by Wellman, Case, Mengert and Bradbury, by Williams and by Poole. Consistent results, especially with the Wellman study, were found.

Another way to validate a new testing instrument is the method of extreme groups.

The subjects are rated on an external criterion and the speech scores of the two extreme groups on the rating are compared. If the difference between the mean scores of these groups is significant, it may be taken as evidence for validation. Templin throughout her study has used as an external criterion socio-economic status. The extremes are the upper and lower socio-economic levels. Frequently throughout the pages of the book the two groups are contrasted. In summary Table 71, *t* values are given showing significances of differences between upper and lower groups on the four major language measures. Of 160 comparisons of the articulation scores of the extreme groups 41, or only 26 per cent, of the differences are significant. Of 8 differences between the groups on the sound discrimination test, 4 of them, or 50 per cent, are significant. Thus, there is some evidence for the validity of the test.

It is evident from the above analysis that a systematic attempt was not made in these tests to meet all the above listed criteria. The usefulness of a new testing instrument, perhaps, does not depend entirely upon meeting all standards. Its success ultimately depends on its ability to successfully evaluate and predict the speech status of a child. It must compete in the market place. In view of the rich experience and scholarship of its author and of the tremendous amount of work which has gone into the project, the practical utility of these tests looks promising indeed.

The amount of attention given in this review to test construction leaves too little space for the consideration of many valuable aspects of the book. However, the chapter on the interrelationships among the several language skills should not be overlooked. It is a distinctive treatment of this problem. The treatment employs correlation methods and significance of differences between consecutively tested age levels. Terminal status measures are presented for each major language area. That is to say, the mean score of the subjects at the 8-year-old level is taken as the measure of terminal status. The percentage of this score attained by each younger age group is calculated One of the findings set forth in the chapter is that there is substantial relationship among the language skills, but the magnitude of the relationship varies with the skill. The highest correlations are found between sound discrimination scores and sound discrimination vocabulary. With intelligence partialled out, the size of the intercorrelations is somewhat reduced. The several language skills show different patterns of increments. The chapter is a real contribution and the speech therapist will find it rewarding reading.

The book is packed with information concerning many matters interesting to speech people. There are helpful comparisons with earlier studies and a vast amount of new and fresh material on the development of language. The study not only is an interesting treatment of speech problems, but it is an exceedingly valuable contribution to the area.

Orvis C. Irwin

University of Iowa

Jones, Morris V. *Speech Correction at Home.* Springfield, Illinois: Charles C. Thomas, Publisher, 1957. Pp. 136. $4.75.

This book, according to the author, tells how friends and family members may help persons with trouble in oral communication to overcome their handicap. There are six chapters in the volume. Chapter I, 'Your Child Learns to Talk,' is well written in non-technical language with a good summary; it should be of general interest to anyone who is concerned about speech problems. Chapter II, 'If Your Child Can't Talk,' discusses the possible causes of delayed speech and, using the question-answer technique, gives many helpful suggestions in that area. A good bibliography is included. 'Correcting Faulty Speech' is the title of Chapter III. It presents a simple test of articulation and a discussion of removing the cause of the problem along with drill materials. This chapter includes very brief sections on foreign accent, cleft palate and cerebral palsy. The bibliography lists additional reading material.

The fourth chapter on 'Stuttering' is well handled. Factors which might affect speech are presented and the question-answer technique is again used to enable the reader to help diagnose the problem and to get at its underlying causes. The chapter stresses the objective attitude and states that 'the adult stutterer will probably never be completely free of non-fluency. But he can learn to control the symptoms and to understand and eliminate certain causal factors.' Chapter V, 'You Will Speak Again,' is addressed to those who must learn esophageal speech.

This chapter is precise and lists in order the steps to practice to enable one to produce esophageal speech. The philosophy expressed is good and should be encouraging to one with this problem. The last chapter, 'Rebuilding Language,' is written for the wife of a man who has had a stroke. The sequence of re-developing language is easy to follow; the author hopes some degree of recovery may be promoted through the approach he suggests.

The book closes with an appendix which gives lessons for each of the speech sounds. The manner and language in which this book is written should make it useful for the intended readers.

GRETCHEN PHAIR
Wisconsin Department of Public Instruction

INGHAM, HARRINGTON V. and LOVE, LENORE R. *The Process of Psychotherapy*. New York: McGraw Book Company, Inc., 1954. Pp. 270. $5.00.

This is an unusual book in that it is written for psychotherapists rather than patients. Therapy is considered in the orthodox pattern of dynamics, rapport, resistance, transference, insight, *etc.*; meanwhile the reader is taken step by step through the workings and evaluations of these procedures. The book is comparable to a series of clinical lectures given to advanced students by experienced psychotherapists. The book shows unusual objectivity in a section devoted to 'evaluation of results.' *The Process of Psychotherapy* should prove to be a useful chart for the young psychiatrist embarking upon the treacherous sea of doctor-patient relationships.

Since speech therapists very frequently include psychotherapy as a part of their remedial procedures, they can gain valuable information about the process from this book.

C. S. BLUEMEL
Englewood, Colorado

BLUEMEL, C. S. *The Riddle of Stuttering*. Illinois: The Interstate Publishing Company, 1957. Pp. 142.

At the age of seventy-three Charles Sidney Bluemel has published what he regards as his last work on stuttering. If it has faults, these will no doubt be apparent to a reader who is on the alert for them. This book is properly evaluated, however, in an historical context in which ordinary faults are irrelevant. Through contributions to the literature which go back to 1913 Bluemel has probably influenced the course of scientific thinking about stuttering as much as any individual. His concept of primary and secondary stuttering has not only powerfully set its stamp on much that has been said and written about the disorder since 1932, but may be said to have led on by virtue of its sharp distinction between simple nonfluencies and struggle behavior to Johnson's diagnosogenic theory. His concepts of stuttering as the inhibition of a conditioned response was apparently the earliest learning theory interpretation of stuttering. His earlier transient auditory amnesia theory was one of the first of the century's grand attempts to solve the mystery of stuttering to which he addresses himself once again in the present book.

The thesis of *The Riddle of Stuttering* is that the difficulty is due to a failure of 'inner' speech. This failure takes the form of a brief obliteration of verbal thought. The observable block which represents the primary symptom of stuttering is simply the 'abortive attempt to articulate while the mind is silent.' Of the relationship between this and his auditory amnesia theory of forty years ago Bluemel says,

> In this earlier psychological theory it was suggested that the verbal image was faint and weak, and that it could not readily be recalled to the speaker's mind. In the present concept, the mental speech is quenched, and thus there is a period of mutism in which oral speech becomes impossible.

In the present book the 'mental' failure is regarded as a disorganization or breakdown under stress and is considered to come about as a result of three conditions. First, it is necessary for speech to be poorly 'organized.' That is, the speaking skills must be insecurely established as they are in most young children and in occasional adults, since 'speech that is poorly made is readily unmade.' Second, the individual must have a personality which is highly vulnerable to stress. He must lack self-possession and be readily confused and frustrated. Bluemel finds the stutterer 'often diffident, sensitive, self-conscious, indecisive, tense and easily confused.' Third, there must be stress. This may come from an unfavorable parental environment, especially an 'atmos-

phere of eager perfectionism' about which Bluemel has much to say. Or it may take the form of excitement, fatigue, shock, injury, illness, operations, speech frustration, chronic conflicts and anxieties or stimulating drugs.

It is to be noted with particular emphasis that all of the above is concerned with 'primary' stuttering and that Bluemel now uses this term to refer, not to effortless, unconscious repetitions, but to blocks or 'spasms' with 'concomitant emotion.' He regards primary and secondary stuttering today as two types of symptoms rather than as two developmental stages. He writes,

> In 1932 and 1935 I confused this simple concept by likening primary stammering to the febrile stage of infantile paralysis and comparing secondary stammering to the paralytic stage of this disease. Yet stammering can only be roughly identified as a two-stage disorder, for primary stammering persists after the conditioning and physical struggle of secondary stammering appear.

Several chapters are devoted to the secondary symptoms of struggle, word and situation fears and the 'phobia and anxiety which pervade the stammerer's inner life.' Fifty pages, or more than one-third of the book, are concerned with treatment, which consists basically of exercises in 'quiet, clear verbal thinking' in which the stutterer does not attempt to talk until he is certain that his 'inner speech' is free of stuttering.

It is interesting to contrast this book with the author's *Stammering and Cognate Defects of Speech* which appeared in 1913, since the things which Bluemel has learned since then afford a partial indication of the progress which has been made in the field as a whole. At least a few outstanding changes are discernible in the present book. One is the emphasis on parental pressures as a factor in the onset of stuttering. Another is the concept that stuttering is a disorder which is influenced at least in part by personality and that stuttering therapy is at least in part psychotherapy. Thirdly, a new form of multicausality is apparent. In 1913 stuttering was said to be precipitated sometimes by disease, sometimes by shock or injury, sometimes by imitation, and so forth. In 1957, on the other hand, stuttering is seen as a *joint product* of several interacting forces. The implication that essentially the same effect may have widely varying causes, an implication which would appear to be somewhat at variance with the assumptions of physics, although it has appeared again and again unchallenged in the field of stuttering both before and after 1913 is gone now. A fourth and particularly heartening sign of professional progress is that in 1957 Bluemel does not find it necessary to devote part of his book to outraged denunciations of a class of pedagogical brigands to whom he referred in 1913 as 'speech specialists.' In fact, the only speech specialists mentioned in *The Riddle of Stuttering* are the American Speech and Hearing Association to whose foundation all royalties from the sale of the book are donated. Last, it is a generally more scientific book that Bluemel has produced today. It is true that little evidence is offered to support its main contentions and there are few references to the multitude of research findings of the past forty years. But the author abundantly reveals that inclination to differ with oneself which is perhaps the purest form of scientific skepticism and there is evident in all that he writes an abhorrence of mysticism and superstition even in their most up-to-date and erudite forms. In these respects Bluemel's present work is more true than ever to the scientific tradition which he helped to foster in speech correction in the United States.

OLIVER BLOODSTEIN

Brooklyn College

SCHONELL, F. ELEANOR. *Educating Spastic Children.* New York: Philosophical Library, 1956. Pp. 242. $6.00.

This book embraces several unique features: first, it is a work by an English author, describing the education of children with cerebral palsy in England; second, it presents the Birmingham Research Project upon which most of the data, analysis and conclusion depend. It is difficult to evaluate such a book since investigation, appraisal, re-appraisal and education of these children has attracted vital interest on the American scene for the past twenty years A great body of literature already exists in America concerning the individual and community problems of children with cerebral palsy. So sensitive have the investigators become to the multi-facet implications of the education of children with cerebral palsy that many publications are the result of concerted cooperation by the specialties involved. Doctor Schonell's book differs in

this respect since the whole book is the result of one individual's efforts. Consequently, the book must be evaluated in terms of its proposed goals which Doctor Schonell defines as: 'The main purpose of the book has been to provide first-hand information of an educational and psychological kind for all concerned with the education, upbringing, and general welfare of the cerebral palsied."

The book is divided into four parts. The first part handles the nature of cerebral palsy and traces the historical development of special educational provisions for these children. Observation reveals that in America, the provision for special education for these children is both a public and private affair with high fees often required of the parents, while in Australia and Great Britain, special education for these children is free.

In considering cerebral palsy, Doctor Schonell employs the usual classification of (1) spastic paralysis, (2) athetosis, (3) ataxia, (4) tremor and rigidity, (5) rigidity. Although her classification is similar to the one used in America, it does not contain refinements that would provide operational efficiency in handling different problems.

The second part deals with the survey in which the book grapples with the problems of estimating the intelligence of cerebral palsied children, the types of tests used, the relationship between intelligence and physical handicap, reading abilities and the cerebral palsied child at home. Doctor Schonell indicates that 24% are normal or above, 27% are dull or slow learners, 45% are mentally retarded and 4% are so severely retarded that no diagnosis is possible. It is interesting to note that she uses Hebb's duplicity theory of intelligence. Part three devotes itself to the practical applications while Part four deals with the psychological and social aspects. In forty pages, Doctor Schonell devotes her attention to the psychology of the cerebral palsied child's habit formation, parent counseling and future developments.

In the writer's opinion, an over-all evaluation of the book reveals one predominating characteristic. The book suffers from simplifititis. Most of the topics are handled in a popular vein even though the book purports to be heavily loaded with the scientific method. The evaluations of the psychological aspects of athetoids and the spastics are examples of popular concepts that are not correctly evaluated. Furthermore, Doctor Schonell does not utilize learning theory in any framework which might reveal the inter-relationships in terms of the perceptive difficulties that these children experience. Although she indicates that the 'study is concerned with the whole group of cerebral palsy cases,' the title of the book is *Educating Spastic Children* which presents a paradox and may be confusing. Science may be considered to be a process of systematic observation of behavioral events which lead to general laws. Consequently, it is questionable whether or not individual cases can be presented to describe general laws. They may illustrate general laws but cannot be taken in isolation. Doctor Schonell employs individual cases for this purpose. The topics are meagerly treated and do not indicate the psychodynamics involved. Hearing and speech behavior are examples. Nevertheless, the book is well written and for the unsophisticated reader, does give an over-all view of the education of these children in England.

Louis M. DiCarlo

Syracuse University

Herdan, G. *Language as Choice and Chance.* Gronigen, Holland: P. Noordhoff, 1956. Pp. 356. $8.00.

This is not a book which will contribute one iota to the therapist, clinician or practitioner as such. It is simply a book on linguistic and literary statistics, lightened by the curious inclusion of a section on *Linguistic Duality* and laden with a fifty-page introduction to statistics. It is intended as a textbook for a seminar in the statistical properties of language and appears to serve that narrow purpose better than any other book known to the reviewer. The book incorporates the studies of earlier investigators (*e.g.*, Zipf, Yule, Shannon, etc.), introduces much new material and attempts the difficult task of weaving the varied contributions into one comprehensive whole.

The book is divided into five parts: *Stylostatistics*, which deals largely with vocabulary measures and their interpretation; *Statistical Linguistics*, which treats phonemic, lexical and grammatical items in frequency distributions and argues that the frequency and combinational structure are just as much a part of the language as the forms themselves; *Information Theory*, which treats language as an efficient code,

examines forces which tend to change languages and makes an interesting application of such statistics to translation problems; *Linguistic Duality*, which deals with the disjunction between languages, between language and the world, and between 'concepts' and language as the real 'choice' element which saves language from 'chance' —pure determinism; and *Statistics for the Language Seminary*, which introduces the reader to descriptive statistics, the normal curve, the binominal, statistical inference, chi-square and correlation—all with linguistic illustrations.

The book may be praised for its wealth of raw data, its attempt to give meaningful interpretations to the statistics employed, its treatment of de Saussure's 'la langue—la parole' distinction and its insistence that linguistic science is itself statistical in nature.

The work may be criticized for its inadequate index, printing errors, occasional word-for-word redundancy (see pages 80 and 95), awkward and sometimes obscure writing and excessive concern with linguist 'duality' which this reader found irrelevant. The reader should further be cautioned that the adequacy and comparability of the data employed in the examples are not treated at all critically.

It is not an easy book to read and it is not, despite the inclusion of the section on introductory statistics, a book for the reader with little or no statistical background. However, it is a book which the student already interested in linguistic statistics, or even in simple 'word counting,' will want to read.

James J. Jenkins
University of Minnesota

Friedrich, Johannes. *Extinct Languages* (translated by Frank Gaynor). New York: Philosophical Library, 1957. Pp. 182. $5.00.

The translator of this originally German work has taken a liberty with the title. The book deals with the methods of written communication employed by the ancient peoples of the general Near East and records a history of their decipherment of modern scholars. Accounts of academic detective work always make for fascination and the present book is no exception, bringing together as it does the details on the decipherment of the Egyptian and Hittite hieroglyphic and the Persian-Akkadian cuneiform writing. One is again introduced to the Rosetta Stone, the inscriptions at Behistun and the person of Champollion. There are also sections devoted to some of the more exotic and less well known inscriptions, such as the Hurrian and Elamitic and to the languages which have so far defied decipherment, such as Etruscan and the Indus Valley scripts. A translator's appendix mentions the unravelling of the Minoan Linear B, now known to be Greek.

The writer's interest has been in the solving of scientific puzzles and it is unquestionably advantageous to have the history of the decipherment of extinct scripts brought together. The disappointing feature is the absence of any statement on the languages represented by the scripts. Not only might it be of interest to have a somewhat fuller statement on the historical affinities of each language discussed—they are known in greater detail than the author gives—but the reader who might wish to follow the tortuous process of decipherment might have been provided with some additional details of linguistic structure. Granted that many of the languages wrote only consonants, vowels in the Semito-Hamitic group being morphophonemic, a reader might welcome some description of phonological patterning. The Greek accentual system, for example, suggests a tonemic element; is there any suggested parallel in cognate Hittite? Speculation on the part of the writer as to how an extinct language was pronounced would prove intriguing to the phonologist.

In summary, we are told much of these languages as systems of visual communication; virtually nothing is said about their oral quality.

Robert F. Spencer
University of Minnesota

Sataloff, Joseph. *Industrial Deafness* (with contributions by Charles R. Williams, Robert Roop, Robert Goldman and John A. Zapp, Jr.). New York: McGraw-Hill, 1957. Pp. 333. $8.00.

For groups interested in noise in industry, 'Industrial Deafness,' a guide to industry on causes and control of hearing loss due to intense noise exposure, is an excellent introduction to the problem. The author has covered the broad field with appropriate references for more detailed reading.

In the preface mention is made of the increasing importance of noise and its effect

on man from the standpoint of industry, the worker's health, his happiness and social relations.

In Part I the physics of sound, physiology of the ear and causes of human deafness, the essence of what must be understood for full appreciation of any practical program to deal with noise in industry are presented. The more controversial subject of the effect of noise on human behavior is covered by quotations from various experimenters whose conclusions are based on opinions from excellent, if not purely scientific, data. Williams summarizes some of the medico-legal opinions that prevail in various states in which the problem has been important because of claims already settled. Wisconsin and New York have laws being carefully watched by other states that are attempting to enact fair legislation. The general considerations of the book end with suggestions for industry in deciding if the conservation of hearing program in a particular industrial environment is needed.

Part II of the book is concerned with the environment where the noise itself must be carefully evaluated. Williams here indicates the principles of noise measurement and the importance of accurate observation in the practical situations where noise can be an industrial health hazard. Damage risk criteria have been elucidated, but the author is careful to indicate that these require much more investigation and application before they can be considered absolute. The wide range of variability in response to the effect of noise on different human ears will preclude rigid criteria unless some reliable test of susceptibility can be devised. Ear protectors offer some degree of partial solution, but these have certain disadvantages.

Goldman discusses the principles of noise abatement, a subject about which industry is increasingly aware. Machinery design and process change will help to make some industrial operations quieter. Roop presents practical information on auditory test rooms in which accurate audiometry is possible.

Part III deals with the individual worker and how his hearing is tested, recorded and followed. Such data will form a fair basis for the determination of claim validity and this is of the utmost importance to industry and the insurance carriers. The variation in standard test results caused by fatigue, presbycusis and malingering will confuse those attempting to evaluate the hearing status in many cases. The personal handicap of deafness with personality and social adjustment of the worker must be thoroughly understood.

As with so many important health problems, the one of industrial deafness will be solved by a cooperative effort with the industrial physician and the otologist taking the lead. An excellent concluding chapter sets forth this relationship. The book ends with a cartoon illustrated chapter on the meaning of a Hearing Conservation Program and there is appended a list of visual aids for training purposes.

NORTON CANFIELD
Yale University

GRAHAM, EARL C. and MULLEN, MARJORIE. *Rehabilitation Literature 1950-1955*. New York: McGraw-Hill Book Company, Inc., 1956. Pp. 621. $13.00. FROHMAN, I. PHILLIPS. *J.A.M.A. Clinical Abstracts of Diagnosis and Treatment*. New York: Grune and Stratton, Inc., 1957. Pp. 564. $5.50.

Speech and hearing specialists may be finding it increasingly difficult to keep up with the greatly expanding knowledge in their own field. They will certainly find this is true in related areas with which they should be at least somewhat familiar. They will find these two books of great value primarily for information in related areas but also for materials in their own specialties.

Of the two books, *J.A.M.A. Clinical Abstracts of Diagnosis and Treatment* has less direct relevance for specialists in the area of speech and hearing. It is admittedly compiled for the medical specialist. The book collects and organizes the abstracts which have appeared in the *Journal of the American Medical Association* for the past year and which relate most directly to diagnosis and treatment. These abstracts are grouped under various subjects—Digestive System; Edocrine System; Ear, Eye, Nose and Throat; *etc.* The abstracts are excellent. This is certainly a book speech and hearing specialists should know about and examine enough to be aware of its potential value as a reference source.

Rehabilitation Literature 1950-1955 has more direct relevance for persons in speech and hearing. The bibliography 'indexes and annotates 5,214 periodical articles, pamphlets, and books related to the medical care, education, employment, welfare, and

psychology of handicapped children and adults. It brings together in one alphabetic listing, by subject, references published in the six-year period from January, 1950, through December, 1955.' The summaries are arranged in alphabetized categories from 'Accidents' through 'Writing.' The major categories have sub-categories such as 'Cerebral Palsy—Diagnosis,' 'Cerebral Palsy —Speech Correction,' *etc.* The summaries are very concise and give a capsule indication of what the book, pamphlet or article is about. For example, Cruickshank's book, *Cerebral Palsy*, is summarized in 13 lines. This brevity is not a deficiency; enough material is given to guide the reader to original sources as his needs and interests may dictate. Each of these books is a valuable and significant reference source.

ERNEST H. HENRIKSON
University of Minnesota

Abstracts

Acoustics of Singing

FRY, D. B. and MANÉN, L. Basis for the acoustical study of singing. *J. acoust. Soc. Amer.*, 29, 1957, 690-692.

Adenoidectomy

GUGGENHEIM, P. Direct adenoidectomy. III. Results. *Arch. Otolaryng., Chicago, 66*, 1957, 26-34.

The author reports the effect upon hearing of direct, visualized adenoidectomy, supporting the particular surgical procedure as well as the routine use of audiometry pre- and post-operatively in such cases. (*J. M. Palmer*)

Articulation

PETTIT, C. W. The predictive efficiency of a battery of articulatory diagnostic tests. *Speech Monographs*, 24, 1957, 219-226.

Sixty children were used in a longitudinal study to determine the efficiency of a battery of generally recognized tests in predicting articulatory development of normal children. The battery of tests used was found not to be efficient in making this prediction. (*D. E. Williams*)

Audiometry

DIEROFF, H. G. Das Atlas-Audiometer EM 40 als behelfsmafsiges kontinuierliches Audiometer. (The Atlas-Audiometer EM 40 as a device for continuous audiometery.) *HNO, Berlin*, 6, 1956-57, 66-67.

The Atlas-Audiometer model EM 40 is described by the author and its use as a device for continuous audiometry is discussed. Continuous tone audiometry is recommended for scientific and clinical threshold determinations. (*E. Froeschels*)

EGAN, J. P. Remarks on rare PB words. *J. acoust. Soc. Amer.*, 29, 1957, 751.

JERGER, J. F. and CARHART, R. T. Continuous versus interrupted stimuli in automatic audiometry. *USAF School Aviat. Med. Rep.*, Mar., 1957, 56-58.

Abstracts is edited by William Tiffany, University of Washington, and by Phillip A. Yantis, University of Michigan, assisted by the following committee: Robert A. Albright, Arizona State College, Tempe; Asa J. Berlin, Pennsylvania State University; Virginia B. Carroll, Minneapolis Veterans Hospital; Alfredo Dub, Hospital Maciel, Montevideo, Uruguay; Emil Froeschels, New York City; Robert Goldstein, Central Institute; A. Bruce Graham, Henry Ford Hospital, Detroit; Morris Halle, M.I.T.; Clair N. Hanley, University of Washington; A. K. Kairies, USN Electronics Laboratory, San Diego; Dominic A. LaRusso, University of Washington; Herbert J. Oyer, Ohio State University; John M. Palmer, University of Washington; Maryjane Rees, Sacramento State College; Frank B. Robinson, Miami University; Vivian I. Roe, University of Indiana; Bernard B. Schlanger, Vineland (N. J.) Training School; James L. Shapley, State University of Iowa; Joseph G. Sheehan, University of California; Adam J. Sortini, The Children's Medical Center, Boston; Barbara S. Street, Minneapolis, Private Practice; Wayne L. Thurman, Eastern Illinois State Teachers College; John C. Webster, USN Electronics Laboratory, San Diego; Deso Weiss, New York City; Dean E. Williams, Indiana University; Abraham Zaliouk, Haifa, Israel.

Ten young adults traced Békésy-type audiograms (1 db/sec attenuator speed) at 250, 1000 and 4000 cps under two conditions: continuous-tone presentation and an interrupted-tone stimulus (on 300 M sec; off 1200 M sec). Mean thresholds for interrupted tones (in decibels) were significantly higher at 250 cps, the same as for continuous tones at 1000 cps, and significantly lower at 4000 cps. The amplitude range of the tracings was always lower with the continuous-tone stimulus, significantly so at 250 and 4000 cps. The variability (standard deviation) among the 10 listeners was never significant for either threshold or range of amplitudes. Interrupted tones were recommended. (*J. C. Webster*)

LAFON, J. C. La distorsion de la perception des phonemes. (Distortion in the perception of phonemes.) *Rev. Laryng., Bord.*, 78, 1957, 239-249.

Phonemes are preferable to words in vocal audiometry. Understanding of a patient's auditory disorder can be found from the threshold for phonemes, from the frequency of errors at supra-threshold intensities and from the kinds of substitutions that are made for the correct phonemes. (*R. Goldstein*)

OEKEN, F. W. Das Ueberhoren bei der Sprachaudiometrie. (Trans-cranial stimulation in speech audiometry.) *HNO, Berlin*, 6, 1956-57, 146-149.

In bone-conduction audiometry the tones in the ear under test might be heard in the other ear via the skull, especially if the latter ear is suffering from an air-conduction problem (which is frequently joined with supernormal bone conduction). If masking noises are used to mask the second ear, these noises may be transmitted via bone conduction to the ear that should be examined. Is speech audiometry safe in this respect? As has been proved in five cases of unilateral nerve deafness, speech audiometry does not avoid difficulties identical to those of tone audiometry. (*E. Froeschels*)

PALVA, T. Recruitment testing. *Arch. Otolaryng., Chicago*, 66, 1957, 93-98.

The author reviews and evaluates various indirect recruitment tests, supports the use of direct measures, and indicates the high reliability of self-recording audiometry and speech discrimination tests for predicting the presence of recruitment. (*J. M. Palmer*)

PALVA, T. Self-recording threshold audiometry and recruitment. *Arch. Otolaryng., Chicago*, 65, 1957, 591-602.

Presented is a report of a study using self-recording threshold audiometry to provide information pertaining to recruitment in a patient. 'At the higher frequencies, at and above 2000 cps, there is a good correlation between small threshold amplitude (excursion) and recruitment.' A similar statement could not be made for the low frequencies. (*J. M. Palmer*)

PICK, E. I. Indications and predictions in stapes mobilization. New method to test hearing during surgery. *Arch Otolaryng., Chicago*, 65, 1957, 586-590.

New methods of case selection and surgical procedure are discussed as well as the instrumentation and technic of surgical 'contact' audiometry during stapes mobilization procedures. (*J. M. Palmer*)

SHIMIZU, H., SUGANO, T., SEGAWA, Y. and NAKAMURA, F. A study in psychogalvanic skin resistance audiometry. *Arch. Otolaryng., Chicago*, 65, 1957, 499-508.

The authors describe successful modifications in the equipment, circuitry and procedure used by them in objective (PGSR) audiometry. (*J. M. Palmer*)

WARD, W. D. The single-descent group audiometer. *Noise Control*, 3, 1957, 15-18.

An audiometric installation for simultaneous pure-tone testing of up to ten individuals is described. An interrupted pure tone (2.25 pulses per second) is automatically decreased 3 db per second from an initial level of 60 to 80 db SPL. Those under test are instructed to press a button when they hear the tones, thus energizing a pen on a continuous event recorder and to press a different button when the tones just disappear. Eight discrete frequencies from 500 to 8000 cps are used by the author and threshold measurements are made by means of a template. Six sources of variability in this technique are discussed. On a typical group of enlisted men it is found that complete audiograms on both ears can be ob-

tained on each subject in approximately ten minutes. (*P. A. Yantis*)

WIEGERS, H. Audiometrie im Operationssaal. (Audiometry in the operating room). *HNO, Berlin,* 6, 1956-57, 65-66.

During some otological operations, especially stapes mobilization for otosclerosis, repeated audiometric tests are necessary. The whisper test and the tuning fork tests are insufficient. The author recommends the use of the Atlas-Audiometer EM 26. The transference from air to bone conduction is prevented by the use of a rubber device. At least the hearing for frequencies 1000, 4000 and 250 cps are examined. Anesthesia with Scopolamine-Eucodal-Ephetonine or Morphine-Atropine does not change the acoustic threshold. At least three audiometric curves are necessary: after local anesthesia, before surgery and after surgery. (*E. Froeschels*)

Aural Harmonics

CHOCHOLLE, R. and LEGOUIX, J. P. About the sensation of beats between two tones whose frequencies are nearly in a simple ratio. *J. acoust. Soc. Amer.*, 29, 1957, 750.

CHOCHOLLE, R. and LEGOUIX, J. P. On the inadequacy of the method of beats as a measure of aural harmonics. *J. acoust. Soc. Amer.*, 29, 1957, 749-750.

LAWRENCE, M. and YANTIS, P. A. In support of an "inadequate" method for detecting "fictitious" aural harmonics. *J. acoust. Soc. Amer.*, 29, 1957, 750-751.

MEYER, M. F. Aural harmonics are fictitious. *J. acoust. Soc. Amer.*, 29, 1957, 749.

Bone Conduction

KONIG, E. Variations in bone conduction as related to the force of pressure exerted on the vibrator. *Trans. Beltone Institute for Hearing Research,* No. 6, 1957, from Les variations de la conduction osseuse en fonction de la force de pression excercée sur le vibrator, *Comptes-Rendus des Seances. 11e Congrès Ordinaire, Société Internationale de'Audiologie,* Paris, 1955, 87-97.

Audiometric measurements are made with a bone-conduction vibrator placed in an adjustable head clamp and applied to the forehead. The effects of vibrator pressure variations on threshold measurements at discrete frequencies from 250 to 8000 cps are studied. It is found that such variations may lead to threshold changes of 15 to 20 db, depending on the vibrator and the frequency tested. The author stresses the importance of defining pressure constants of bone-conduction vibrators provided with commercially available audiometers. (*P. A. Yantis*)

Brain Injury

BENDA, C. E. and HOESSLY, G. F. Postnatal and natal cerebral injuries. *Arch. Neurol. Psychiat.*, 76, 1956, 236-246.

TEUBER, H. and WEINSTEIN, S. Ability to discover hidden figures after cerebral lesions. *Arch. Neurol. Psychiat.*, 76, 1956, 432-443.

Sixty-four brain-injured veterans were administered 'hidden-figures' tests. The test results were evaluated in terms of the locus of brain lesions. None of the results differentiated brain-injured groups. However, the aphasic cases performed significantly worse than non-aphasic brain-injured cases. It appeared that impairment on 'hidden-figure' tests followed lesions in any lobe of the brain without regard to the presence or absence of visual or sensory symptoms. (*J. J. O'Neill*)

Brain Physiology

NOBACK, C. R. and MOSS, M. L. Differential growth of the human brain. *J. com. Neurol.*, 105, 1956, 539-551.

A general descriptive statement relative to changing proportions of parts of the human brain during growth is set forth. Data were obtained from 121 fetuses and 43 adults. Growth gradients were determined for fourteen dimensions of the brain from the end of the second fetal month to the adult stage. Except for two dimensions, ratios of specific growth were proportional throughout the period. The exceptions were (1) corpus callosum and (2) width of the cerebellum. A method of expressing differential growth is proposed in what is termed the 'allometric growth equation.' (*H. J. Oyer*)

Bulbar Polio

KAPLAN, S. Paralysis of the swallowing mechanism following bulbar poliomyelitis. *Arch. Otolaryng., Chicago*, 65, 1957, 495-498.

Presented is 'a new surgical procedure for the restoration of swallowing in patients who have lost this function as a result of bulbar poliomyelitis.' The author describes the rationale, procedure and results of sectioning the cricopharyngeous muscle when it fails to relax and dilate the hypopharynx. (*J. M. Palmer*)

Cerebral Palsy

BLUEMEL, J., EVANS, E. B. and EGGERS, G. W. N. Hereditary cerebral palsy. *J. Pediatrics*, 50, 1957, 454-458.

Using a family group as illustration, the authors discuss sex-linked inheritance as one of the causes of cerebral palsy. (*B. B. Schlanger*)

HIPPS, H. E. Basic teaching-training principles for the patient with cerebral palsy. *Brit. J. of Phys. Med.*, 20, 1957, 34-38.

LEVITT, S. Cerebral palsy—a critique of the evaluation of therapy. *Brit. J. of Phys. Med.*, 20, 1957, 127-132.

A critical survey of records of the cerebral palsied child is made from the point of view of the clinical worker in physical medicine. Treatment techniques are suggested. (*H. J. Oyer*)

Cerebral Palsy Speech

LORENZE, E. J. and SOKOLOFF, M. A. Clinical evaluation of speech deficiencies in cerebral palsy. *Arch. phys. Med.*, 38, 1957, 442-449.

This is a report of one hundred ninety-two consecutive referrals to the Cerebral Palsy Clinic of the Burke Foundation. All '. . . were given complete evaluations, including speech evaluations.' The observed speech deficiencies are rated as complete, severe, moderate or mild. The deficiencies are also divided into seven categories representing causes of delayed language development and into several types of disorders of speech production. The incidence of each degree of deficiency for each type of speech deviation is presented as a percentage of the 192 cases examined. The authors summarize a number of implications they draw from these percentage values. The prognosis for the development of adequate speech on the three-year-old level is then discussed in terms of the type and cause of a speech deficiency. (*J. L. Shapley*)

Cleft Palate

BEDER, O. E., COE, H. E., BRAAFLADT, R. P. and HOULE, B. A. Factors associated with congenital cleft lip and cleft palate in the Pacific Northwest. *Oral Surg., Oral Med., Oral Path.*, 9, 1956, 1267-1273.

A statistical analysis is made of 433 medical histories of cleft lip and cleft palate patients of the Northwestern area of the United States. The factors investigated are types of clefts, their incidence, sex, the effect of birthrank, maternal age, hereditary background, race and the incidence of associated anomalies. These factors are compared with those obtained in other areas. (*A. K. Kaires*)

GRABER, T. M. Oral and nasal structures in cleft palate speech. *J. Amer. dent. Assn.*, 53, 1956, 693-706.

'It appears that to assess the caliber of cleft palate speech, the observer must do more than examine the function of the repaired palate. This has been the major consideration in the past. Nasopharyngeal growth gradients, the type and degree of hearing loss, the amount and character of tonsillar and adenoid tissue, the degree of anterior movement of the posterior pharyngeal wall, the deflection of the nasal septum and the amount of obstruction of the nasal airways by the inferior turbinates, the posture and function of the tongue and the nature and degree of the malocclusion all contribute to the final product. Each factor must be studied and developed to its fullest extent if the goal of normal speech is to be realized.' (*Author's precis*)

JANVIER, H. L'utilisation du lambeau pharyngé dans la fermeture des divisions palatines. (The use of a pharyngeal strip in closure of cleft palates.) *Rev. Laryng., Bord.*, 78, 1957, 8-88.

A strip is cut in the mucosa and muscle of the posterior wall of the pharynx. It is

left hinged from above at a level just a little above the base of the tongue. This strip is then used to close the palatine cleft. In some children older than 7 or 8, and in some adults this type of surgical repair is said to have resulted in 'practically normal phonation.' (*R. Goldstein*)

LLOYD, R. S., PRUZANSKY, S. and SUBTELNY, J. D. Prosthetic rehabilitation of a cleft palate patient. *J. Pros. Den.*, 7, 1957, 216-230.

A case report is presented of a cleft palate patient with a previous history of multiple surgical and prosthetic failures. Cephalometric and laminagraphic findings are presented to demonstrate the structural and functional deficits. The objectives of the treatment plan are to improve speech and cosmetics. These objectives are attained by the construction of a prosthetic appliance of suitable design to correct the deficiencies. The final result is documented by a series of cephalometric roentgenograms. (*A. K. Kaires*)

NIFIFFER, T. J and SHIPMON, T. H. The hollow bulb obturator for acquired palatal openings. *J. Pros. Den.*, 7, 1957, 126-134.

The author lists the indications for the use of an obturator. The advantages and technique for constructing a hollow bulb obturator are described. A case report of a patient with a palatal defect and its correction is presented. (*A. K. Kaires*)

PRUZANSKI, S. The foundations of the cleft palate center and training program at the University of Illinois. *Angle Orthodont.*, 27, 1957, 69-82.

A review of the Cleft Palate program at the University of Illinois from inception to present status is presented. Progress is measured in terms of changing surgical approach, completed and contemplated research and plans for further development of the program. (*C. N. Hanley*)

Counseling Parents

LEVITT, M. and ROBENSTEIN, B. The fate of advice: examples of distortion in parental counseling. *Ment. Hyg.*, 41, 1957, 213-216.

The authors contend that some parents can do little with 'educational suggestions' in psychological counseling because of unconscious elements in their personality structures which 'often cause the distortion, nullification and even on occasion the reversal of well-intended advice.' Four cases are discussed in which this problem is illustrated. (*W. L. Thurman*)

Delayed Sidetone

BUTLER, R. A. and GALLOWAY, F. T. Factorial analysis of the delayed speech feedback phenomenon. *J. acoust. Soc. Amer.*, 29, 1957, 632-635.

'Two experiments, employing a total of 388 subjects, were conducted to further study factors influencing performance on the delayed speech feedback task. The rate of presenting reading material, the intensity, and length of delay of speech feedback served as independent variables. A linear relation was found between performance on the feedback task and intensity of the delayed signal. There was an interaction between intensity and delay time of speech feedback, clearly demonstrating that various delays are differentially effective only at high intensity levels. That the role of delay is more than a simple interference factor produced by background noise was also demonstrated.' Visual presentation of written paragraphs and flashing numbers were used as stimuli and the authors concluded that flashing numbers provide more motivation with a greater subsequent stability of results. (*P. A. Yantis*)

GIBBONS, E. W. and WINCHESTER, R. A. A delayed sidetone test for detecting uniaural functional deafness. *Arch. Otolaryng., Chicago, 66*, 1957, 70-78.

'Seventy cases of uniaural organic deafness were studied in order to validate a new, objective delayed sidetone test designed to detect uniaural functional deafness. The investigation resulted in the following findings: 1. Delayed sidetone testing techniques can detect a uniaural functional deficit. 2. Clinical utilization of these testing techniques is feasible in standard audiology clinics. 3. The results of the testing technique are objective and their interpretation is easily achieved. Specific instructions for presenting the delayed sidetone test are given.' (*Authors' precis*)

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Ear Pathology and Surgery

ALTMANN, F. The ear in severe malformations of the head. *Arch. Otolaryng., Chicago, 66,* 1957, 7-25.

ANTHONY, W. P. Congenital and acquired atresia of the external auditory canal. *Arch. Otolaryng., Chicago, 65,* 1957, 479-486.

The author presents studies of cases of congenital and acquired atresias. Specialized surgical technics are described and end results, including hearing changes, reported. (*J. M. Palmer*)

BASTERRECHEA-ZUBIETA, C. and BERTRAN-ESCANAVERINO, R. Notre expérience dans l'opération de Rosen. (Our experience with the Rosen operation.) *Rev. Laryng., Bord.,* 78, 1957, 23-30.

The authors describe their own variations of the stapes mobilization operation and their results on 69 patients. Their criteria for success are: (1) the patient says he hears better after the operation, and (2) one month after the operation there is at least a 10 db improvement in threshold for 500, 1000 and 2000 cps. (*R. Goldstein*)

BELL, H. L. Recent advances in the management of deafness. *Eye, Ear, Nose, Throat, Mon.,* 36, 1957, 34-38.

Outstanding events leading to modern otologic surgery are discussed. A brief history of the fenestration and stapes mobilization operations is given. The more recent tympanoplasty method is also discussed. Ninety percent of conductive deafness is said to be amenable to either medical or surgical therapy. (*H. J Oyer*)

BJORKESTEN, G. Unilateral acoustic tumours in children. *Acta Psychiat. Neur. Scand.,* 32, 1957, 1-5.

Typical neurinomas of the eighth nerve are rare in children less than 15 years of age. The author presents a case history with clinical findings of a unilateral acoustic neurinoma occurring in a girl of 12 years old. (*B. S. Street*)

BORGHESAN, E. An experimental contribution to the physiopathology of the cochlea. *Acta Otolaryng.,* 47, 1957, 473-479.

'The author submits that a cochlear trauma may cause different kinds of alterations in the order of Corti and in some of them he recognizes the anatomo-pathological findings of the deafness of interruption. The experimental results may provide an anatomo-pathological basis to some hypotheses put forward about the functions of the cochlear structures he has found.' (*D. A. LaRusso*)

HABERMANN, G. Neuere Gesichtspunkte zur aetiologischen Differenzierung angeborener Schwerhorigkeit und Taubheit. (New views on the etiologic differences of congenital hearing loss and deafness.) *HNO, Berlin,* 6, 1956-57, 129-132.

A disturbed metabolism of the embryo might be due to morbid genes or exogene factors such as high temperature. Therefore in virus infections it might be not only the toxic influences of the viruses, but also high temperature which could cause organ disturbances. Lack of oxygen might disturb all the oxydative processes in an irreversible way even after a few hours. Lack of glucose, which might be due to bleeding or to an abnormal umbilical cord, could also have damaging effects. The so-called ultra viruses have a specific affinity to organs that need a high amount of oxygen, such as the lens and Corti's organ. Some blood diseases of the newborn will work similarly. Excessive vomiting of the mother might also be dangerous. (*E. Froeschels*)

HALL, A. and RYTZNER, C. Stapedectomy and autotransplantation of ossicles. *Acta Otolaryng.,* 47, 1957, 318-324.

'A brief report of a new surgical method on the transmission mechanism of the middle ear is presented. This technique is used in cases where interruption of the ossicular chain has occurred. The purpose of the method is to restore the connection between the tympanic membrane and the oval window by using autogenous transplantation of the ossicles. The theoretical background of the procedure is discussed and a presentation of some of the successful results is made.' (*Authors' precis*)

INGALLS, T. H., KELEMEN, G. and CURLEY, F. J. Development of the inner ear after maternal hypoxia. *Arch. Otolaryng., Chicago, 65,* 1957, 558-566.

LEMPERT, J. The dry physiologically perfected fenestra nov-ovalis technique. A technique for predictable restoration and conservation of serviceable hearing in clinical otosclerosis. *Arch. Otolaryng., Chicago,* 66, 1957, 35-45.

MEURMAN, O. H. A study of refenestration. *J. Laryng. Otol.*, 71, 1957, 116-122.

A report is given of twenty-five refenestrations completed at the Otolaryngological University Hospital of Helsinki. Eight additional fenestrations are reported in which new fenestras were created on the ampullary end of the superior semicircular canal together with the usual refenestration surgery. A Thiersch graft is divided to cover both the old and new fenestras. (*C. N. Hanley*)

MUFTIC, M. K. Acetazolamide in Ménière's disease. *Arch. Otolaryng., Chicago,* 65, 1957, 575-579.

PORTMANN, M., CLAVERIE, G. and PRADEAUX, P. La chirurgie des fenêtres labyrinthiques das les syndromes otospongieux. (Surgery of the labyrinthine windows for the syndrome of otosclerosis.) *Rev. Laryng., Bord.*, 78, 1957, 38-59.

Pathologic modifications of the stapes and labyrinthine windows are described in patients operated on for reduction of hearing loss due to otosclerosis. The authors recommend that surgery of the stapes should vary according to the particular pathologic condition and not be restricted to simple mobilization. Forty-eight of 80 patients subjected to the varying procedures showed improvement of between 10 to 45 decibels in sensitivity. (*R. Goldstein*)

PORTMANN, M. and DAVID, J. L. Le facteur héréditaire dans les surdités. (The hereditary factor in deafness.) *Rev. Laryng., Bord.*, 78, 1957, 205-238.

Heredity may be responsible for hearing losses in at least three ways. (1) Genetic factors may be directly responsible for improper development or for degenerative changes in various parts of the ear and auditory nerve. (2) Allergic tendencies, indirectly responsible for many ear infections and subsequent hearing losses, may be inherited. (3) Susceptibility of the ear to damage by drugs or by noise may be inherited. The third item deserves more study and attention than has been given to it. (*R. Goldstein*)

SOHOEL, T. The course of bone conduction after fenestration operation. *Acta Otolaryng.*, 47, 1957, 462-472.

According to the author, surgical alterations which produce post-fenestration pathology will be reflected in bone conduction. Using 35 cases, the investigator gathered bone conduction thresholds in both pre- and post-operative situations. Techniques of measurement included use of an oscillator applied to the forehead, similar pressure for each frequency measured and effective masking of the normal ear. Over 600 audiograms are said to demonstrate a definite post-operative improvement in bone conduction in all frequencies tested (250, 500, 1000, 2000, 3000, 4000) and a positive correlation between this improvement and a favorable prognosis. The article contains a survey of some pertinent literature which reviews the mechanism of bone conduction in otosclerosis. (*D. A. LaRusso*)

SVANE-KNUDSEN, V. Intracranial findings in a late case of acute, 'idiopathic' deafness. *Acta Otolaryng.*, 47, 1957, 459-461.

The author reports that, in a case previously diagnosed as acute, 'idiopathic' deafness, acoustic neuritis was more probably the pathological condition involved. (*D. A. LaRusso*)

ZDRAVEV, P., PORTMANN, M., CLAVERIE, G. and GRIMALDI, P. A propos des tympans artificiels. (Concerning artificial tympanic membranes.) *Rev. Laryng., Bord.*, 77, 1956, 865-877.

Surgical considerations in tympanoplasty are discussed. Examples are presented of audiograms before and after tympanic repair by cauterization, by closure with some inert substance and by closure with some biologic material. (*R. Goldstein*)

Ear Physiology

BÉKÉSY, G. v. Sensations on the skin similar to directional hearing, beats, and harmonics of the ear. *J. acoust. Soc. Amer.*, 29, 1957, 489-501.

'A mechanical model of the cochlea in which the skin of the arm is used as a sense organ was compared with the organ of Corti. Three phenomena were investigated: (1) directional hearing, (2) beats, and (3) harmonics. For directional hearing almost no differences were found between hearing and the sensation produced by the model. In the case of beats it was possible to confirm the earlier observations of Helmholtz by improving the frequency resolution of the model ear. Concerning the harmonics it was found that the method of best beats does not permit the measurement of overtones of the ear.' (*Author's precis*)

BÉKÉSY, G. The ear. *Sci. Amer.*, 197, 1957, 66-78.

Here is a summary of current information on the anatomy and function of the ear. After a discussion of the capabilities of the human ear, the author describes the structure from the tympanic membrane to the auditory nerve and its mechanical operation in sound reception. The relationship of speech and hearing, the function of feedback and the suppression of sounds are described. Present knowledge of the auditory nerve and brain functions in the reporting and analysis of sound is summarized. The author describes chief causes of deafness and corrective surgery now available. He concludes with a plea for protection of our hearing from damaging influences and for understanding for the deafened. Drawings and graphs are included. (*W. L. Thurman*)

BORGHESAN, E. Aspects morphologiques, structuriels et fonctionnels des cellules de Deiters. (Morphologic, structural and functional aspects of Deiters' cells.) *Rev. Laryng., Bord.*, 78, 1957, 9-22.

Deiters' cells, as well as Claudius' and Hensen's cells, have as their main function the regulation of interstitial fluid of the organ of Corti (endolymph) and the transferral of the fluid to the hair cells. Their supporting role is more incidental and more complex than ordinarily described. (*R. Goldstein*)

MATSUOKA, K., KONISHI, T. and NAKAMURA, F. Electric impedance of the cochlea and its significance for evaluating cochlear microphonics. *Acta Otolaryng.*, 47, 1957, 325-335.

The authors believe that present measurements of cochlear microphonics are not as accurate as they should be since the electrical impedance of the cochlea has not been satisfactorily computed. Using adult guinea pigs as subjects, the investigators tested a new method of computing this impedance of the inner ear with pure tones of various frequencies as stimuli. Most notable of the results obtained are those which show that the (1) '. . . magnitude of the cochlear potential computed from the measured electric impedance of the pathway to the electrode in the cochlea has a uniform value for all tones from 200 cps to 1000 cps and then rather sharply decreases and continues to fall as the frequency is raised,' and (2) cochlear hair cells produce electrical energy in a manner directly related to the stimulating tone frequency. (*D. A. LaRusso*)

SHIMIZU, H., KONISHI, T. and NAKAMURA, F. An experimental study of adaptation and fatigue of cochlear microphonics. *Acta Otolaryng.*, 47, 1957, 358-363.

This article reports the results of an experiment designed to measure cochlear microphonics for the purpose of investigating adaptation and fatigue in the organ of Corti. Recording electrodes were fitted into the scala media and the scala tympani of anesthetized guinea pigs and pure tones between 1000 cps and 4000 cps at 70 to 90 db were used as stimuli. The stimulation time alternated between 20-30 minutes and 4-6 seconds. Results are reported to show that (1) high intensity sounds decreased the electric impedance of the cochlear partition, (2) long, loud stimulation tends to decrease cochlear microphonics, and (3) auditory adaptation and fatigue in this area may be described in terms of an 'increase of ion diffusion on the hair cell membrane and decrease of electric charge of the cell membrane.' (*D. A. LaRusso*)

TONNDORF, J. Fluid motion in cochlear models. *J. acoust. Soc. Amer.*, 29, 1957, 558-568.

Using a transparent-plastic model of the cochlea, scaled to a size five times that of the human cochlea, the author studied the motion of glycerin-water in response to sound. His purpose was to learn something regarding the displacement of the cochlear duct by perilymphatic fluid motion in the

cochlea. Results are discussed in reference to membrane motion, eddy motion, particle motion and response to complex tones. Other observations are mentioned. (*P. A. Yantis*)

Esophageal Speech

DAMSTE, P. H., VAN DEN BERG, J. W., and MOOLENAAR-BIJL, A. J. Why are some patients unable to learn esophageal speech. *Ann. Atol., etc., St. Louis*, 65, 1956, 998-1005.

A thin polyethylene catheter inserted into the upper third of the esophagus through the nose is described and its use in developing speech for laryngectomees is defined. (*C. N. Hanley*)

Facial Paralysis

WINTER, S. T. Facial paralysis in poliomyelitis. *Pediatrics*, 19, 1957, 876-880.

Fifty-eight young children showing facial palsy during the acute phase of poliomyelitis were re-examined 23 to 43 months after the onset. Twenty-six children showed complete recovery. Residual weakness was noted in 21 patients. The author indicates that unfavorable prognostic signs include the presence of bulbar lesions, involvement of the upper facial muscles and failure to improve after about 18 months. Appreciable facial weakness is a frequent deformity following poliomyelitis. (*B. B. Schlanger*)

Frequency Analysis

GROEN, J. J. and VERSTEEGH, R. M. Frequency modulation and the human ear. *Acta Otolaryng.*, 47, 1957, 421-430.

The authors conducted several experiments for the purpose of discovering information concerning the 'analysing power for frequency of the human ear for complex sounds.' Sinusoidal frequency modulation was selected for the stimulation since it combined both the 'constant regulable strength' of pure tones and the complexity of human speech. The investigators found that the 'complex sound can be analysed as long as the difference in frequency between its successive components does exceed their critical band widths.' Further, 'whenever the difference in frequency between two or more harmonic vibrations, which are simultaneously presented to the ear, is less than their critical band width, a simultaneous frequency analysis in the sense of Ohm's law is no longer possible.' They conclude that, although the capacity for successive frequency analysis is determined by a time constant of about 60 msec exposure, the human ear is quite able to handle analysis of the complex sound used in the investigation. (*D. A. LaRusso*)

Frequency DL's

MICHAELS, R. M. Frequency difference limens for narrow bands of noise. *J. acoust. Soc. Amer.*, 29, 1957, 520-522.

Frequency difference limens were measured for filtered white noise having band widths of ½ to 64 cps centered at 800 cps and for a pure tone of the same frequency. 'Six listeners were used, and the DL's were defined as the probable errors of the fitted transition curves. For band widths wider than 8 cps, the DL rises regularly. Between ½ to 8 cps the threshold changes are small, having a minimum at about 8 cps. None of the DL's for noise approach that of the pure tone, all being at least twice as large.' The author discusses his suggestion that the differences in DL characteristics of noise and tones are due to the dependence of frequency discrimination on intensity discrimination. (*P. A. Yantis*)

Fusion of Sounds

BROADBENT, D. E. and LADEFOGED, P. On the fusion of sounds reaching different sense organs. *J. acoust. Soc. Amer.*, 29, 1957, 708-710.

'It is shown that synthetically produced speech will fuse when the first formant is presented to one ear and the second to the other, but it will not do so if the formants are given different fundamental frequencies. Even when both formants are given to the same ear, the latter condition fails to fuse. A further experiment with sustained formants shows that binaural fusion is not explained by the identity of some of the Fourier components on the two ears.' The authors feel their results lend weight to a 'multiple' theory of hearing rather than to a simple place theory. (*P. A. Yantis*)

Glosso-Velar Action

GUILLEN, G., GOSPODNETIC, Y., WANGERMEZ, J. and POMMEZ, J. La synergie glosso-vélaire.

(Glosso-velar synergy.) *Rev. Laryng., Bord.*, 78, 1957, 89-91.

A summary is given of the findings in an X-ray motion picture of vocal mechanisms during phonation. The principal emphasis is on the simultaneous actions of the tongue and the velum which together modify the resonant cavities of the pharynx. (*R. Goldstein*)

Growth Chart

NAIMARK, G. M. The 'Growth Spectrum': A simplified chart for the assessment of growth. *J. Pediatrics*, 50, 1957, 586-590.

The author describes the Growth Spectrum which is a chart visually emphasizing different patterns of growth by utilizing several colored weight and height zones. In addition to simplifying record keeping, the chart enables the physician to define the child's individual physique, determine whether his rate of growth conforms to the developmental pattern of his specific physique and simplifies the assessment of growth and development and the prediction of physical dimensions. (*B. B. Schlanger*)

Hearing

FISCH, L. The importance of auditory communication. *Arch. Dis. Childh.*, 32, 1957, 230-235.

The author describes in general terms the role of hearing in speech and language development, the need for early detection of deafness in children and several approaches to the matter of determining the existence of hearing losses in children. (*J. L. Shapley*)

Hearing Aids and Audiometers

EWERTSEN, H. W., IPSEN, J. B. and NIELSEN, S. S. On acoustical characteristics of the earmould. *Acta Otolaryng.*, 47, 1957, 312-317.

The investigators set out to measure the tone production of a hearing aid type of earphone with various earmoulds *in situ* and on an artificial ear. The results of the investigation are said to show that the earphone tone production can be measured on both the human and artificial ears with reliable results. In addition, results are said to support the belief that earmoulds with short, wide canals reproduce high frequencies better than those with long, narrow canals. 'Secret ears' tended to impede the reproduction of high frequencies greatly. (*D. A. LaRusso*)

LEHMANN, M. R. La necessité de l'homologation des appareils de correction auditive et de la normalisation des audiometrès. (Necessity for standardizing hearing aids and for normalizing audiometers.) *Rev. Laryng., Bord.*, 78, 1957, 179-204.

After a review of the standards in various countries for hearing aids, the author evaluates the existing standards in France and suggests further criteria for satisfactory aids. He also reviews various efforts to determine audiometric zero and suggests methods of calibrating audiometers for both air and bone conduction. (*R. Goldstein*)

NELSON, B. E. Hearing aids and lip reading. *Nat. Hearing Aid J.*, 10 (3), 1957, 6, 18.

The value of hearing aids used in conjunction with lip reading is observed. The author feels that optimum understanding involves maximum utilization of hearing and vision. (*C. N. Hanley*)

PRALL, J. Group and wearable hearing aids in a residential school for the deaf. *Annals of the Deaf*, 102, 1957, 240-250.

The merits of group versus wearable hearing aids are discussed with special reference to their use in residential schools. Special emphasis is placed on the use of the group hearing aid in an auditory training program. (*C. N. Hanley*)

WERTH, P. C. Application problems of on-the-head hearing aids. *Hearing Dealer*, 7 (4), 1957, 11-13, 45-46.

Hearing in Noise

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, COMMITTEE ON CONSERVATION OF HEARING, SUBCOMMITTEE ON NOISE IN INDUSTRY. Guide for conservation of hearing in noise. *Noise Control*, 3, 1957, 23-31.

'The purpose of this Guide is to assist members of the industrial community in their efforts to protect hearing. The information presented here describes how to determine whether a noise exposure calls for hearing conservation and, if it does, how to organize, conduct, and monitor a practical hearing conservation program.'

The subcommittee recommends that all industrial employees be given a pre-placement air conduction audiometric examination at 500, 1000, 2000, 3000, 4000 and 6000 cps. If a hearing loss averaging 15 db at 500, 1000 and 2000 cps is found, otological examination and placement evaluation are advised. Periodic follow-up audiometric screening tests are recommended after 90 days of employment in an excessively noisy environment and hearing conservation procedures should be instituted when an employee has a threshold shift of 15 db or more in the direction of increased hearing loss at one or more of the six frequencies tested. Methods of measuring noise levels, environmental control of noise, personal protection from exposure, and standard testing equipment and procedures are also discussed. (*P. A. Yantis*)

HELPER, M. M. The effects of noise on work output and physiological activation. *US Army Medical Research Lab. Rep.*, 270, Oct., 1956.

'Three physiological variables (skin conductance, pulse interval, and muscle tension) were recorded during performance of a mental task, during exposure to 110 db noise, and during the noise and task combined. Noise by itself was found to be relatively non-stressful. However, it appeared that noise added slightly to the physiological cost of mental work, even though noise did not affect task performance. No correlation was found between physiological reactions to noise and the effects of noise on performance.' (*Author's precis*)

HINCHCLIFFE, R. Threshold changes at 4 Kc/s produced by bands of noise. *Acta Otolaryng.*, 47, 1957, 496-509.

The author concerned himself with the physical effects of white noise on the auditory threshold at 4 Kc/s in the hope that an accurate Damage Risk Criterion could be constructed. Four adult males were stimulated with narrow bands of noise for one minute periods. By comparing audiograms made during pre- and post-exposure periods, the author found that all subjects experienced a polyphasic recovery curve when subjected to the 4 Kc/s frequency, but a diphasic response when subjected to 3 Kc/s frequency. He postulates that ' . . . provided the noise intensity is insufficient to produce a polyphasic post-stimulatory threshold change at 4 Kc/s, exposure to noise for long periods will not result in occupational deafness.' (*D. A. LaRusso*)

PALVA, T. Occupational deafness in telephone exchange workers. *Acta Otolaryng.*, 47, 1957, 510-519.

Studies were carried out on the effect of telephone alarm signals of the order of 130 db on the hearing of persons employed for transmitting from and to the city of Turku. Of 139 employees employed in the communication department, 19 persons, or 13.7 percent, were found to have a dip-type hearing loss exceeding 20 db, mainly in the area between 1500 and 4000 cps. This corresponded well with the type of receiver used by the employees: the main emphasis of amplifying was on the low tones with an extra peak before 1000 cps. (*D. A. LaRusso*)

PELL, S. The relation of occupational noise exposure to loss of hearing acuity. *Arch. Otolaryng., Chicago, 66*, 1957, 79-92.

The author presents an analysis of audiometric studies of workers in noise environments of three intensity levels over a period of five years. Results are reported in terms of effect of noise at each level, type of hearing loss found, increment of loss with time and the susceptibility of ears at age levels. (*J. M. Palmer*)

SCHULTHESS, G. v. Evaluation of hearing impairment due to industrial noise. *Arch. Otolaryng., Chicago, 65*, 157, 512-520.

Continuous frequency audiometry was administered to cement plant workers exposed to high noise levels, before and after work-shifts, before and after vitamin A administration, and before and after use of earplugs in work. Noise-sensitive ears were discovered and positive effects of both vitamins and noise protection devices were reported. (*J. M. Palmer*)

Hereditary Deafness

EVERBERG, G. Hereditary unilateral deafness. *Acta Otolaryng.*, 47, 1957, 303-311.

Disturbed by the paucity of information on the problem of hereditary unilateral deafness, the author undertook a study of four families with histories of this defect, with particular emphasis on the influence

of exogenous factors. A positive conclusion regarding the comparative roles of exogenous and endogenous factors in the families observed could not be offered by the investigator at this time. (*D. A. LaRusso*)

Hysterical Dysphonia

POMMEZ, J. Les dysphonia pithiatiques. (Pithiatic or hysterical dysphonia.) *Rev. Laryng., Bord.*, 78, 1957, 60-68.

Information

MOLES, A. La notion de message multiple: application au message oral. (The notion of a multiple message: application to the oral message.) *Rev. Laryng., Bord.*, 77, 1956, 972-980.

VALLÉE, R. Information selective et information sémantique. (Selective information and semantic information.) *Rev. Laryng., Bord.*, 77, 1956, 981-985.

Intelligence in Hemiplegics

SHONTZ, F. C. Evaluation of intellectual potential in hemiplegic individuals. *J. clin. Psychol.*, 13, 1957, 267-269.

The Knox Cube Test and the Columbia Mental Maturity Scale were used with 50 hemiplegic, hospitalized patients (17 right, 33 left). All patients were found testable using these two instruments and the author reports they can appropriately be used for the evaluation of intellectual capacities without unduly penalizing the patient for aphasia or loss of manual dexterity. (*V. B. Carroll*)

Intelligence of the Deaf

HISKEY, M. S. A Study of the intelligence of deaf and hearing children. *Amer. Ann. Deaf*, 101, 1956, 329-339.

Originally the Nebraska Test of Learning Aptitude was standardized on four hundred sixty-six deaf children between four and ten years of age. It has recently been standardized on three hundred eighty hearing children. It can be administered using pantomimed or verbal instructions. The author suggests that since there is high correlation between the Nebraska Test and the Binet Scale, it can be employed with confidence as a measure of intelligence. (*H. J. Oyer*)

Intelligibility

FAIRBANKS, G. and KODMAN, F., JR. Word intelligibility as a function of time compression. *J. acoust. Soc. Amer.*, 29, 1957, 636-641.

'An experiment is described in which words were automatically compressed in duration and presented to observers for identification. The effects of time sampling are assessed, and compared with those of periodic interruption. The results of an analogous nonauditory study of the effects of phonemic sampling are presented.' (*Authors' precis*)

FLANAGAN, J. L. Estimates of the maximum precision necessary in quantizing certain 'dimensions' of vowel sounds. *J. acoust. Soc. Amer.*, 29, 1957, 533-534.

PETERS, R. W. A rating scale technique for the measurement of speaker intelligibility. *USN School Aviat. Med. Rep.*, 68, Feb., 1957.

'The purpose of the present experiment was to evaluate the technique of measuring speaker intelligibility through listener ratings of voice samples on an equal-appearing intervals scale. The technique was evaluated for validity, reliability, and the effect of different S/N ratios upon mean scale values. The results indicate that the scaling technique provides a fairly good estimate of speaker intelligibility. The rating scale values of intelligibility appear to be reasonably reliable and are influenced by the listening conditions under which the ratings are made by listeners. The method appears to have promise for measuring intelligibility in situtions where standardized intelligibility measures are not applicable.' (*Author's precis*)

PICKETT, J. M. Perception of vowels heard in noises of various spectra. *J. acoust. Soc. Amer.*, 29, 1957, 613-620.

'The perception of vowels heard in noises of various spectra is analyzed by means of stimulus-response matrices. The stimulus vowels were spoken in PB-word lists and in syllable lists in which the vowels were equally probable. The matrices show shifts in vowel confusions depending on how different noise spectra mask the vowel formants. Vowel duration and intensity are

measured and related to vowel perception. Vowel guessing is related to past training.' (*Author's precis*)

Language

ABORN, M. and RUBENSTEIN, H. Word-class distribution in sentences of fixed length. *Language*, 32, 1956, 666-674.

'Samples of printed English sentences of three lengths were drawn randomly from a representative selection of popular magazines. The words of each sentence were classified according to Fries's system and a count was made of the various word classes at each sentence position. The tabulations were plotted as frequency distributions and treated statistically. Principally, the data obtained from all three sentence lengths indicate (1) that the greatest variations in word-class frequency tend to occur in sentence extremes and the immediately adjoining positions, and (2) that different word classes have characteristic patterns of variation.' (*Authors' precis*)

STERN, T. Drum and whistle 'language': An analysis of speech surrogates. *American Anthropologist*, 59, 1957, 487-506.

Laryngeal Pathology and Surgery

FIOR, R. Heredity in cancer of the larynx. *Acta Otolaryng.*, 47, 1957, 407-409.

SNITMAN, M. and LOEWY, A. Adequate surgery in carcinoma of the larynx. *Arch. Otolaryng., Chicago, 65*, 1957, 469-473.

SZPUNAR, J. Treatment of papillomatosis of the larynx in children. *Acta Otolaryng.*, 47, 1957, 369-374.

Larynx Physiology

OBREGON, G. A study of one hundred cases of neck dissection. *Arch. Otolaryng., Chicago*, 66, 1957, 54-57.

PORTMANN, G. The physiology of phonation. *J. Laryng. Otol.*, 71, 1957, 1-15.

The author presents a review of the myoelastic and clonic theories of phonation. He cites evidence obtained by himself and others in support of the latter theory. To account for the frequency of nerve impulses necessary in a clonic explanation of phonation, the author calls upon 'Polyphasis Recurrential Conduction,' a kind of volley theory for the recurrent nerve. The author concludes, 'The clonic theory that I have just exposed is, in my opinion, very important because with it the larynx is no more a muscular organ with its own physiology, but it enters into the frame of the neuro-muscular physiology' and 'only this conception permits us to devise efficient therapeutics for many troubles of the voice.' (*W. R. Tiffany*)

VAN DEN BERG, J., ZANTEMA, J. T. and DOORNENBAL, P., JR. On the air resistance and the Bernoulli effect of the human larynx. *J. acoust. Soc. Amer.*, 29, 1957, 626-631.

Measurements of the air resistance of the larynx as a function of subglottic pressure, the dimensions of the glottis and the pressure in the laryngeal ventricle are made on a positive impression of a plaster cast of a normal human larynx. The mathematical results obtained are discussed with reference to various problems of normal voice production. (*P. A. Yantis*)

Learning of Stimulus Words

BOUSFIELD, W. A., ESTERSON, J. and WHITMARSH, G. A. The effects of concomitant colored and uncolored pictorial representations on the learning of stimulus words. *J. appl. Psychol.*, 41, 1957, 165-169.

Loudness Function

STEVENS, S. S. Concerning the form of the loudness function. *J. acoust. Soc. Amer.*, 29, 1957, 603-606.

'In order to examine certain possible irregularities in the loudness function, the method of adjustment was used to halve and double the loudness of a 1000-cy tone at the levels 30, 60, 90, and 120 db *re* 0.0002 microbar. . . . The results . . . indicate that a reasonable approximation to the loudness function is the rule that a change of 10 db corresponds to a loudness ratio of 2:1. This means that loudness grows approximately as a power function of intensity. It is noted that the power function also describes the relation between psychological magnitude and stimulus magnitude on a dozen other perceptual continua.' (*P. A. Yantis*)

Loudness Summation

ZWICKER, E., FLOTTORP, G. and STEVENS, S. S. Critical band width in loudness summation. *J. acoust. Soc. Amer.*, 29, 1957, 548-557.

'The concept of the critical band, or Frequenzgruppe, is shown to apply to loudness summation. When the spacing between a group of pure tones is increased, the loudness remains constant until a critical point is reached, after which the loudness increases. The same effect occurs when the width of a band of noise of constant SPL is made larger. The critical band width at which loudness summation begins to depend on the spread of energy is approximately the same as the critical band width determined previously by methods involving thresholds, masking and phase. . . . The relation of the critical band to other functions is noted.' (*P. A. Yantis*)

Manometer

AVAKIAN, E. A. Automatic and digital manometer for recording physiological pressures. *Amer. J. phys. Med.*, 36, 1957, 71-77.

The author provides a rough schematic and certain constructional details for a versatile manometer. The device incorporates a manometer tube containing an electrically conducting liquid. As the fluid rises in the tube, electrodes along the length of the tube are serially shorted to ground, thereby activating a rotary stepping relay. The author discusses in particular the clinical application of the device in speech therapy for cerebral palsy and cleft palate cases. In this connection, it is pointed out that negative pressures (as from sucking) can be recorded as easily as positive pressures. (*J. L. Shapley*)

Masking

DEATHERAGE, B. H., BILGER, R. C. and ELDREDGE, D. H. Remote masking in selected frequency regions. *J. acoust. Soc. Amer.*, 29, 1957, 512-514.

'Masked audiograms for six different masking stimuli were obtained from five observers. The audiograms show that remote masking can be controlled with respect to frequency region by controlling the envelope of the masking sound. Regular variations in the envelope at, say, 500 cps produce remote masking in the 500-cps region; while irregular, 'random,' variations produce equal amounts of masking everywhere outside the frequency region corresponding to the masking band or tone. It is argued that the constant masking seen in remote masking is related to the fact that signal frequencies are differentially attenuated in their transmission from the tympanum to the cochlear partition, while the masking frequencies are not since they are actually generated in the cochlear partition itself.' (*Authors' precis*)

Noise Thresholds

HAMILTON, P. M. Noise masked thresholds as a function of tonal duration and masking noise band width. *J. acoust. Soc. Amer.*, 29, 1957, 506-511.

'Noise masked thresholds for 800 cps tonal pulses 25 to 400 msec long were measured in masking noise bands from 19 to 1100 cps wide. It was found that the threshold remained constant for equal values of band width, pulse-length product.' (*P. A. Yantis*)

WENTWORTH-JESSOP, J. and VIGOUREUX, P. Comparison of threshold of hearing for bands of noise and for pure tones. *Nature*, 178, 1957, 374-375.

Twenty-seven subjects made threshold comparisons between specific pure tones and specific bands of noise. Thresholds for a 1200 cps tone were compared with thresholds for a 800-1600 cps band of noise. Also, thresholds for a 2000 cycle tone were compared with thresholds for a 1500-3300 cps band of noise. The critical band width formulation was employed to compute the expected intensity ratio required for the threshold values of the pure tones and noise. The predicted ratio was on the order of 12-14 db to 1 db. However, the actual test results indicated a ratio of 1 db to 3 db. (*J. J. O'Neill*)

Perception

FLAVELL, J. H. and DRAGUNS, A. A microgenetic approach to perception and thought. *Psychol. Bull.*, 54, 1957, 197-217.

The term microgenetic refers to the sequence of events which are assumed to occur in the temporal period between the presentation of the stimulus and the formation of a single, relatively stabilized cogni-

tive response (percept or thought) to this stimulus. Evidence is offered both to support the possibility that such microdevelopments do occur and to suggest some of the formal characteristics of such evolutions. In addition, an attempt is made to delineate some of the possible implications of this approach for cognitive functioning in schizophrenic and aphasic individuals. Implications for studying normal individuals under atypical conditions are also discussed. Consideration is given to current problems and future research possibilities in relation to a microgenetic framework. (*B. S. Street*)

Pharynx

Atkinson, M., Kramer, P., Wyman, S. M. and Ingelfinger, F. J. The dynamics of swallowing. I. Normal pharyngeal mechanisms. *J. clin. Invest.*, 36, 1957, 581-588.

This study, using 30 subjects, investigated the mechanism of swallowing and the nature and magnitudes of the forces involved. Intraluminal pressures were recorded simultaneously from three levels in the pharynx and esophagus. At the same time rapid serial radiographs were taken to enable interpretation of pressure records in terms of anatomical function and movement of bolus. Results indicated that two peaks of pressure occurred in the pharynx, the first coinciding with the entry of the bolus and the second with constrictor contraction. No pressures lower than normal esophageal pressures were recorded during the passage of the bolus, indicating that swallowing does not involve suction. A further finding supports the view that the cricopharyngeus is a true sphincter. (*B. B. Schlanger*)

Bosma, J. F. Studies of the pharynx: 1. Poliomyelitic disabilities of the upper pharynx. *Pediatrics*, 19, 1957, 881-907.

Roentgenographic studies of impairments in control of the upper pharynx were carried out over a period of seven years in a group of 27 children and adults who had had poliomyelitis. A useful classification of poliomyelitic impairments of the pharynx was derived with recognition of the compensatory and alternative maneuvers they invoke. The author discusses the related impairments of swallowing and speech which result from deficient control of the oropharyngeal and the palatopharyngeal orifices. Abnormal nasality is said to be the most common residual disability of speech. The author believes that improvement of nasality probably depends more upon guided selective vocalization than on exercises of oropharyngeal inflation. (*B. B. Schlanger*)

Kramer, P., Atkinson, M., Wyman, S. M. and Ingelfinger, F. J. The dynamics of swallowing. II. Neuromuscular dysphagia of pharynx. *J. clin. Invest.*, 36, 1957, 589-595.

Disorders of the swallowing mechanism of seven patients with dysphagia are detailed. The causes for the dysphagia are related to the neuromuscular pathology. (*B. B. Schlanger*)

Labarraque, L. Le pharynx vocal. (The vocal pharynx.) *Rev. Laryng., Bord.*, 78, 1957, 69-81.

The author cites evidence and elaborates the theoretical basis for the importance of the pharynx in voice production. (*R. Goldstein*)

Vaheri, E. and Harma, R. Simple fibromas of the pharynx. *Acta Otolaryng.*, 47, 1957, 536-539.

Phonetics

Kaires, A. K. Palatal pressures of the tongue in phonetics and deglutition. *J. Pros. Den.*, 7, 1957, 305-317.

'The objectives in this study are to measure quantitatively, by electronic means, under predetermined vertical dimensions of occlusion (1) the palatal pressures of the tongue in the pronunciation of select palatolingual speech sounds, and (2) the palatal pressures of the tongue in the act of swallowing saliva. It was found that compensatory tongue changes resulted not only in changes of the magnitude of palatal pressures, but also in the time interval in which those pressures were applied. The optimum pressures were obtained with the correct vertical dimension of occlusion.' (*Author's precis*)

Lisker, L. Closure duration and the intervocalic voiced-voiceless distinction in English. *Language*, 33, 1957, 42-49.

Three experiments are described which involve [p-b] combinations. The purpose is to determine whether the difference in duration of closure for these sounds as ob-

served in spectrograms has differential cue value. The results of the experimentation suggest that closure-durational differences are important in the voice-voiceless stop distinction in the type of context studied. (*H. J. Oyer*)

PIKE, K. L. Abdominal pulse types in some Peruvian languages. *Language*, 33, 1957, 30-35.

The author suggests that study of abdominal pulse types makes possible another way of discussing some of the inter and intra language differences. It is implied that phonological units larger than the phoneme must be taken into consideration in linguistic analysis. (*H. J. Oyer*)

Phonics

HERR, S. E. Phonics clinic. *Instructor*, 66 (9), 1957, 35-38.

In addition to presenting information on phonics, the author outlines a sequence of phonics activities and offers a developmental program of phonics teaching. (*B. B. Schlanger*)

Pitch Discrimination

THURLOW, W. R. and BERNSTEIN, S. Simultaneous two-tone pitch discrimination. *J. acoust. Soc. Amer.*, 29, 1957, 515-519.

'The frequency separation between two simultaneously sounding tones necessary to give perception of two pitches has been investigated. Frequency levels of 200, 1000, 4000, 6000, and 10000 cps were used. For the two-ear condition (where one tone was led to one ear, the other tone to the other ear), no striking differences were found between results at sensation levels of 10, 30, and 50 db. When both tones were led to the same ear, results tended to approach the two-ear situation when masking and interaction effects were minimized. The relation of the two-ear results to localization is discussed. Finally special phenomena are described which arise when two low frequencies, related by simple multiples, are used in the two-ear situation.' (*Authors' precis*)

Pitch Rating of Vowels

HARBOLD, G. J. Pitch ratings of voiced and whispered vowels. *USN School Aviat. Med. Rep.*, 67, Feb., 1957.

The problem was to investigate listener judgments of voiced and whispered vowels in an effort to compare the relative pitch of voiced and whispered speech. The results are said to indicate, at least for those vowels that showed significant differences, that tonality may not be the sole determinant of listeners' pitch judgments. The hypothesis is advanced that the relative pitch of vowels is not independent of the vowel itself. (*J. C. Webster*)

Postlaryngectomy Rehabilitation

LUEDERS, O. W. Evaluation of postlaryngectomy rehabilitation programs. *Arch. Otolaryng., Chicago*, 65, 1957, 572-574.

The author discusses reasons for failure in the rehabilitation of laryngectomees and recommends a team comprised of the laryngologist, the speech pathologist or esophageal voice teacher and the psychologist to protect against failure through proper examination and program planning. (*J. M. Palmer*)

Prosthedontia

KESSLER, H. E. Phonetics in denture construction. *J. Amer. dent. Assn.*, 54, 1957, 347-351.

Some of the dental factors associated with complete and partial dentures in their relation to phonetics are discussed. The author advocates the use of a tape recorder as an important adjunct to a prosthodontist's equipment. The observation is made that those patients who speak a language other than English have less trouble phonetically with their dentures. The mechanics of speech production is illustrated for the English alveolingual sounds [n, l, t, d, s, z] and the foreign linguadental sounds [n, l, t, d, s, z]. (*A. K. Kaires*)

MALSON, T. S. Nonobstructing prosthetic speech aid during growth and orthodontic treatment. *J. Pros. Den.*, 7, 1957, 403-415.

The construction of an obturator and speech appliance is described. Emphasis is given to the anatomic structures and their relation to the parts of the appliance. A movable, replaceable disk on the speech appliance provides for ease of adjustment during growth, development and treatment. (*A. K. Kaires*)

SILVERMAN, M. M. Determination of vertical dimension by phonetics. *J. Pros. Den.*, 6, 1956, 465-471.

A speaking method is described to determine the closest speaking space in patients with natural dentition, in those with artificial dentures and in those patients without any records or dentures. The pronunciation of [s] is used to indicate the closest speaking space. The author describes the closest speaking space as the distance between the lower centric occlusion line and the upper closest speaking line. This space is the measurement for vertical dimension. The measurement is verified by repetition, by the pronunciation of other sibilants and by rapid reading. The measurement of the closest speaking space is reproduced in the complete dentures thereby incorporating the proper vertical dimension. (*A. K. Kaires*)

Psychogenic Deafness

GETZ, S. B. Theoretical note on some types of psychogenic deafness, *i.e.*, central, conductive, perceptive. *Acta Otolaryng.*, 47, 1957, 491-495.

The author attempts to explain how various children, without organic difficulty, can 'imitate' audiometric patterns of organic nerve deafness. He posits the thesis that the nature of the psychogenic deafness is defined by the emotional needs of the individual; that types of psychogenic deafness ' . . . follow the dynamic rules of psychosomatic symptoms rather than the stable patterns of organic deficiency.' (*D. A. LaRusso*)

Retardation

COLEMAN, R. W. and PROVINCE, S. Environmental retardation (hospitalism) in infants living in families. *Pediatrics*, 19, 1957, 285-292.

Schizophrenic Children

EISENBERG, L. The course of childhood schizophrenia. *Arch. Neurol. Psychiat.*, 78, 1957, 69-83.

The author reviews outstanding efforts made by workers in psychiatry on the problem of schizophrenia. He states that approximately one-fourth of the cases can be expected to attain good social adjustment during adolescence, one-third will deteriorate and the remainder will fluctuate about a marginal level. Language function is said to be an important variable in achieving a fair to good social outcome. (*H. J. Oyer*)

GOLDFARB, W. Receptor preferences in schizophrenic children. *Arch. Neurol. Psychiat.*, 76, 1956, 643-652.

A descriptive summary is given of receptor behavior of early-school-age schizophrenic children. The children exhibited auditory and visual avoidance or inattention as well as exaggerated use of contact receptors. The schizophrenic child attempts to exclude perceptual experience and behaves as if overcome by confusion and disorientation. (*J. J. O'Neill*)

Signal Detection

GREEN, D. M., BIRDSALL, T. G. and TANNER, W. P., JR. Signal detection as a function of signal intensity and duration. *J. acoust. Soc. Amer.*, 29, 1957, 523-531.

'The object of this study was to determine how signal amplitude and duration effects the detectability of a pure tone partially masked by random noise. If signal duration and amplitude are considered two dimensions in a space, the study attempted to determine the surface of detectability in this space. To accomplish this task three experiments were conducted with the same observers in each experiment. In the first experiment signal duration was held constant while amplitude was varied. In the second experiment signal energy was held constant while various pairs of values of signal duration and amplitude were tested. Finally, signal amplitude was held constant while signal duration was varied. A three parameter equation was determined which provided a reasonable fit to this surface of detectability in the plane of signal amplitude and duration. The equations are consistent with the data of previous research in this area. Finally, a comparison of the results and the predictions generated by a simple filter model is discussed.' (*Authors' precis*)

Speech Communication

TOLHURST, G. C. The effects of disrupting the simultaneity of visual-aural communication channels to a speaker. *USN School Aviat. Med. Rep.*, 66, Dec., 1956.

Forty-eight speakers received the messages they were to impart to listeners in a face-to-face situation. The aural channel was delayed 0.23 second from that of the visual presentation for 24 of the speakers. This experiment showed that when speakers receive material they are to impart to groups of listeners from a reader whose aural signals are not in synchrony with his facial gestures, the resultant speech to the listeners is as intelligible and has the same sound pressure level as the speaker's speech, but is significantly longer in duration. (*J. C. Webster*)

Speech Education

BUTLER, K. Even the stalwart stumble. *Education*, 77, 1956, 108-111.

The author addresses herself to the elementary school teacher, recommending ways in which speech awareness and speech improvement may be effected and conflicts resolved through proper speech hygiene. (*V. I. Roe*)

Speech Maturation

SMITH, M. Relation between word variety and mean letter length of words with chronological and mental ages. *J. Gen. Psychol.*, 56, 1957, 27-43.

Records of the conversations of 97 preschool children were analyzed in terms of 500 word samples. The results of the analyses indicated that for each age level from two to five years there was an increase in the number of different words over that of preceding age levels. Letter length showed only a slight increase with age. It appeared that MA was the most important factor in determining word variability. To further determine the effects of age on word variability and the length of words, analyses were made of samples of the writings of two older women. These analyses were said to indicate that increases in word variety and length hold up until past 60 years of age. (*J. J. O'Neill*)

Speech Problems in Polio

BOSME, J. F., GOATES, W. A. and NEILSON, M. A. Mechanisms of disability of speech resulting from poliomyelitis. *Ann. Otol., etc., St. Louis*, 66, 1957, 67-85.

A number of special speech problems involved in poliomyelitis-based disabilities are covered. Evaluation and therapeutic aspects of the following areas are discussed: deficiency of respiration, abnormal laryngeal function, suspension impairment of the tongue, hyoid and larynx, patency of the palatopharyngeal isthmus and deficiency of lingual articulation. A general discussion also emphasizes the complexities involved in physiological disabilities and their concomitant psychological problems. Of note is the role which the therapist should play in preparing the patient to deal objectively with his limitations. (*C. N. Hanley*)

Speech Reading

SALTZMAN, M. Factors in learning speech-reading. *Arch. Otolaryng., Chicago*, 65, 1957, 425-427.

Teaching the Deaf

BINDON, D. M. Personality characteristics of rubella deaf children: implications for teaching of the deaf in general. *Annals of the Deaf*, 102, 1957, 264-270.

MITRA, A. C. Auditory training for the deaf. *Deaf in India*, 8(3), 1956, 1-8.

RAJA, K. C. K. Social adjustment of the deaf child and the adolescent. *Deaf in India*, 8(3), 1956, 23-30.

Verbal Behavior

GOTTSCHALK, L. A., GLESSER, G. C. and HAMBRIDGE, G., JR. Verbal behavior analysis. *Arch. Neurol. Psychiat.*, 77, 1957, 300-311.

The investigators test content and form variables in speech that are relevant to personality adjustment and explore differences in language patterns in neurotic and psychotic reaction types. Eleven psychiatric in-patients and eleven subjects not hospitalized for mental illness talked for five minutes without interruption. Two methods of eliciting verbal responses were employed: one simulated the clinical interview and the other simulated the projective test situation. A difference was noted in the rate of speech per minute between groups. The non-hospitalized group showed no significant trend in variations in rate of speech per minute for either type of five minute verbal sample whereas the hospitalized

group showed a significant downward trend for both verbally and visually induced speech samples. (*H. J. Oyer*)

Voice Disorders

GARDE, E. J. Un cas de dysphonie fonctionelle d'origine corticale. (A case of functional dysphonia of cortical origin.) *Rev. Laryng., Bord.*, 78, 1957, 31-37.

After two cerebral vascular accidents, a 55-year-old patient showed defects in voice as well as in perceptive abilities. Weakness in speaking voice, loss of singing voice and laryngeal hypotonia as well as some difficulties in linguistic comprehension argued for a bilateral cortical lesion more marked in the left temporal region, as well as a subcortical lesion in the region of the corpus striatum. An immediate post-mortem examination grossly confirmed the sites of the lesions. (*R. Goldstein*)

HOFMANN-SAGUEZ, R. and ALBITRECCIA. Les asomatognosies dans les troubles de la voix et de la parole (Asomatognosias in voice and speech difficulties.) *Rev. Laryng., Bord.*, 78, 1957, 169-178.

Many vocal problems commonly designated as functional laryngopathies would be more appropriately labeled 'phonatory apractognosias.' Patients in this category often manifest disturbances of body scheme (asomatognosia) in formal tests and often show abnormal electromyograms from the pharynx and larynx. Therapy in these cases should be directed toward somatognosic re-education: re-education of kinesthesia, tactile sensations, spatial concepts and articulation. (*R. Goldstein*)

PENHA, G. Traitement psychothérapique des dysphonies de la puberté. (Psychotherapeutic treatment for dysphonia of puberty.) *Rev. Laryng., Bord.*, 77, 1956, 1029-1037.

Many disturbances of voice during puberty are not necessarily accompanied by serious endocrine disorders. Such dysphonias have been successfully treated with judicious use of recordings as the principal tool. The authors claim immediate and permanent success in most cases. (*R. Goldstein*)

News And Announcements

Significant Trends in the Professions

At the International Voice Conference dealing with laryngeal research, physiology and therapy held in May, 1957, at Northwestern University, Mr. W. E. Gould, President of the William and Harriet Gould Foundation, announced an annual award for outstanding research in the field of laryngology. First recipient of this award was Dr. K. Faaborg-Andersen of Copenhagen for his electro-myographic studies of internal laryngeal muscles in humans.

D. E. Morley, Associate Professor of Speech, University of Michigan, is the fifth United States Speech Specialist to go to Norway on a Fulbright grant. Professor Morley delivered four lectures in Bergen, Norway, and spent the past academic year in Oslo where he had his headquarters in the Norway State Hospital. Reporting on the status of speech therapy in Norway, Professor Morley mentioned that there is a specialized public school for children with speech defects which has been operating for nearly 40 years.

Mrs. Lillian Anderson, formerly with the Cerebral Palsy Mobile Unit of the California Elks Association, has been visiting various treatment centers for the speech handicapped in Paris, France. She reports that, at present, there are no facilities for speech correction on either the grade school or the high school level in France. Patients with speech disorders are treated either in hospitals or by means of private practice throughout the country. Patients are directed to the treatment centers by their physicians, according to the specific diagnosis. There is a special service devoted exclusively to adult aphasics, another one for cleft palates and still another for children with language disorders due to emotional problems. Mrs. Anderson is working under the supervision of Dr. Hindermeyer, who has a complete staff of an occupational therapist, several physical therapists and a psychologist at the Enfants Malades Hospital in Paris. There is also an in-patient service for cerebral palsy children. Mrs. Anderson states that the student training program consists of an intensive study handled jointly by the Faculty of Medicine and the Faculty of Letters at the Sorbonne.

'Folia Phoniatrica,' the international Journal of Speech Pathology, appears quarterly and contains articles in English, French and German with summaries of each article in each of these three languages. The publishers are prepared to supply this periodical to members of the ASHA in the United States at a reduced rate of $6.90 per annum, instead of $8.45, if a sufficiently large number is interested in the offer. Those already subscribing would have the benefit of the reduction also. For subscriptions write to S. Karger A. G., Arnold Bocklinstrasse 25, Basel, Switzerland.

News and Announcements is edited by Mary W. Huber, Los Angeles State College, assisted by the following committee: Sue Earnest, San Diego State College; Lester L. Hale, University of Florida; Henry Moser, Ohio State University; Severina Nelson, University of Illinois; Max Nelson, Michigan State College; and Bernard Stoll, University of Kansas.

News and Announcements

For the past two years, with a grant from the Hogg Foundation, Texas Christian University's Speech Clinic has conducted research in the area of acquisition of functional speech by the trainable retarded child. The Fort Worth Women of Rotary

have granted the project $1,200, permitting extension of the work for two additional years. Dr. E. L. Pross and Mrs. Dorothy Bell will supervise the work.

Establishment of two fellowships in Audiology and Speech at Northwestern University is announced by the American Hearing Society, its member agency, the St. Paul Hearing Society, and Northwestern University. The new training program will be geared to preparing qualified persons for work in local hearing societies. The fellowships, made possible by a bequest from the Myers Foundation of St. Paul, Minnesota, are to be known as The Reine Humbird Myers Fellowships. Each fellowship will pay $3,000 a year for two years. Applicants may write to Crayton Walker, executive director, American Hearing Society, 1800 H St., N. W., Washington 6, D. C., or to Dr. Raymond Carhart, School of Speech, Northwestern University, Evanston, Illinois.

Paul Moore, Ph.D., and Hans Von Leden, M.D., of Northwestern University Medical School, Chicago, Illinois, were awarded the Silver Robot at the III International Congress for Specialized Cinematography in Rome, Italy, for the Film, 'The Larynx and Voice,' which shows a new method of studying laryngeal functions, permitting the early discovery of disease in that area. The film was produced at the Voice Research Laboratory of Northwestern University Medical School under a grant from the William and Harriet Gould Foundation, a Chicago foundation for medical research.

A federal training grant of $30,000 has been awarded for the fourth consecutive year to the Cleveland Hearing and Speech Center. George Fortune, Director of the Center, will direct the training of ten students for administrative positions in the hearing and speech field.

The Fourth Postgraduate Course in Esophageal Speech and Organic Voice Problems, University of Miami School of Medicine, will take place June 16-27, 1958. Specialists in otolaryngology, physical medicine and rehabilitation and speech therapy are eligible to apply. Government traineeships valued at $250 each (tuition and traveling expense) are available. Applicants write: Dr. Homer F. Marsh, Dean, University of Miami School of Medicine, Coral Gables, Florida.

Meetings Announced

American Association for Cleft Palate Rehabilitation, St. Francis Hotel, San Francisco, California, April 24-26, 1958.

International Association of Logopedics and Phoniatrics, London, England, August 17-22, 1959. For information write Peggy Carter, L.C.S.T., 46 Canonbury Square, London, N. I.

New Materials

'Stuttering: Therapy in Action,' the proceedings of a session of the Thirty-Second Annual Convention of the ASHA has been published and reprints may be ordered from the Secretary-Treasurer's office, Speech and Hearing Clinic, Wayne State University, Detroit 2, Michigan. Price—$1.00.

The Encyclopedia of American Associations is published by the Gale Research Company which announces the release of a supplement including nine hundred national associations, societies, organizations and labor unions. Each listing includes the national headquarters, executive secretary, number of members, founding date and a brief description of the activities and purpose. The directory, including the new supplement, is priced at $15.00 and is available from the Gale Research Company, 1116 Book Tower, Detroit 26, Michigan.

'Getting the Most out of your Audiometer' is a new bulletin published by the Allison Laboratories, Inc. The article gives information on how to check an audiometer for proper operation and is of value to any user of an audiometer, regardless of the make involved. The Allison Laboratories will send a copy to anyone who requests it, without obligation. Write Allison Laboratories, Inc., Electronic Developments, 14185 Skyline Drive, La Puente, California.

'Is your Child Beginning to Stutter?' is a brochure for parents written by Miss Elvena Miller, Supervisor of Speech Correction, Seattle, Washington, Public Schools. A

bibliography of helpful reading for parents is included. Write Miss Elvena Miller, Seattle, Washington, Public Schools.

A thirty-minute sound-color movie entitled 'Children with Cleft Palates' has been completed and is available for rental or purchase through the Audio-Visual Center of the University of Michigan. The film presents a program of speech development for children born with oral clefts and is designed for showing to both professional and lay groups and is particularly adaptable for showing to parents of cleft palate children.

'The Joy of Listening' is a new film on hearing conservation produced by the Hearing Conservation Section and the Education Section of the Michigan Department of Health. Designed for the general public, the film briefly discusses the importance of hearing and communication; then it shows a modern hearing conservation program and what it accomplishes. The film is a 16 mm, black and white, sound film of television length—13 minutes. For information regarding preview or purchase, write to Courtney D. Osborn, Chief, Hearing Conservation Section, Division of Maternal and Child Health, Michigan Department of Health, Lansing 4, Michigan.

'The Case of Jim' is a standard 12-inch unbreakable vinylite record, 33 1/3 RPM, the verbatim recording in therapeutic counseling with a speech-handicapped young man. A booklet, intended for class use, is available as an adjunct to the record; it contains all of the verbatim material on the record and also a section on personality and adjustment. The counselor is Dr. Julius Seeman, Professor of Psychology at George Peabody College for Teachers. The price of record and booklet is $5.50, plus postage. Write to: Educational Test Bureau, 2106 Pierce Ave., Nashville, Tennessee.

'A Handbook for Speech Improvement, Kindergarten—Grades One to Six' was prepared by The New England Speech Association Committee on Speech Education in the Elementary Schools. It was designed to give the classroom teacher some special suggestions and materials for teaching children to use voices which are pleasing, expressive and easily heard, to articulate speech sounds clearly and to enjoy sharing their own ideas in discussions. New England Speech Association, c/o Boston University Speech and Hearing Center, Boston, Massachusetts.

Graduate Assistantships, Fellowships and Scholarships

Training Fellowships. Vanderbilt University School of Medicine. Programs leading to the Master of Science degree in speech correction, audiology or teaching of hearing-impaired children. Fellowships pay tuition and monthly stipend of $100.00-$130.00 for twelve months. Address: Forrest Hull, The Bill Wilkerson Hearing and Speech Center, 2109 Garland Avenue, Nashville, Tennessee.

Clinical Assistantships. Speech and Hearing Clinic, Pennsylvania State University. Twenty hours per week: stipends of $1,206, $1,305, and $1,404 for regular school year, waiver of tuition fees, may enroll for 10 credits per semester. Ten hours per week: stipends of $603, $652 and $702 for regular school year, waiver of tuition fees, may enroll for 13 credits per semester. Address: E. T. McDonald, Director, Speech and Hearing Clinic, Pennsylvania State University, University Park, Pennsylvania.

Clinical Assistantships. Purdue University. Starting February, Summer or September. Twenty hours per week of clinical assistance: $1,700 for regular school year (10 months); $2,040 for calendar year (12 months); waiver of tuition fees. Student may enroll for 10 hours of graduate course work per semester. Ten hours per week clinical assistantships also available. Student may enroll for 14 hours of graduate course work per semester. Address: M. D. Steer, Speech and Hearing Clinic, Purdue University, Lafayette, Indiana.

Research Assistantships. Purdue University. Starting February, Summer or September. Twenty hours per week of research assistance on U. S. Office of Education research project involving development and evaluation of clinical methods for mentally retarded: $1,500 for regular school year (10 months) or $1,800 for calendar year (12 months); waiver of tuition fees. Student may enroll for combination of full

course load with research. Address: M. D. Steer, Speech and Hearing Clinic, Purdue University, Lafayette, Indiana.

Teaching Assistantships. Department of Speech, Purdue University. Starting February or September, half-time. Teach two sections of Principles of Speech, serve as drill-master for several sections of remedial voice and articulation drill course or serve as clinician in the Speech and Hearing Clinic: $1,700 for the academic school year (10 months); waiver of tuition fees. Student may enroll for 10 hours of graduate courses per semester. Address: M. D. Steer, Speech and Hearing Clinic, Purdue University, Lafayette, Indiana.

Special Announcement

The International Congress on the Educational Treatment of Deafness to be held at the University of Manchester, England, from July 15-23, 1958, is being organized with the approval and support of the Council of the University, with financial help from the Ministry of Education, the National College of Teachers of the Deaf and the Rathbone Trustees with the co-operation of the British Council and the Alexander Graham Bell Association for the Deaf, Inc., Washington, D. C.

The Congress is being planned to bring together educators, audiologists, otolaryngologists, pediatricians, medical officers and educational psychologists to consider and discuss, for the future development of their work, the significance of the results of modern research on problems of deafness in childhood.

Arrangements are being made to offer accommodation to members of the Congress in University Halls of Residence. The cost of this type of accommodation is expected to be about £1. 2. Od. per day, including bed, breakfast and dinner. The University Refectory will be available for meals during each day.

For those who wish to do so, arrangements will be made to visit audiology clinics and special schools in London, Oxford and other places. It is also planned to organize tours to places of interest.

Forms of application for membership in the Congress will be supplied upon request to Professor A. W. G. Ewing, Department of Education of the Deaf, The University, Manchester 13, England.

INDEX TO VOLUME 22, 1957

Journal of Speech and Hearing Disorders

Each article is indexed in two ways: it is listed alphabetically by the last name of the author, and it is also classified under a selected group of subject headings. An article may be located either by the author's name or by the subject matter of the article. Many articles are classified under more than one subject heading. The following subject headings are currently being employed in indexing the *Journal:*

ASHA

- Convention
- General

EXPERIMENTAL PHONETICS

- Acoustic Phonetics
- Auditory Feedback
- Communication Theory
- Intelligibility
- Physiological Phonetics
- General

HEARING (AUDIOLOGY)—CLINICAL

- Audiometry
- Disorders
- Hearing Aids
- Recruitment
- Therapy
- General

HEARING (AUDIOLOGY)—EXPERIMENTAL

- Physiological Acoustics
- Psychoacoustics
- General

JOURNAL DEPARTMENTS

- Abstracts
- Book Reviews
- Graduate Theses in Speech and Hearing Disorders

INDEX

- News and Announcements

LANGUAGE

- Aphasia
- Delayed Speech
- Phonetics
- Speech and Language Development
- General

PROFESSIONAL INTERESTS

- Administration and Organization
- General

SPEECH PATHOLOGY

- Aphasia
- Articulation
- Cerebral Palsy
- Cleft Palate
- Dysarthria
- Examination and Evaluation
- Laryngectomy
- Stuttering
- Voice
- General

SPEECH THERAPY

- Aphasia
- Articulation
- Cerebral Palsy
- Cleft Palate
- Dysarthria
- Laryngectomy
- Stuttering
- Voice
- General

AUTHOR INDEX

Battin, R. Ray (see Blackman, Ruth S.)
Beasley, Jane E., Children as Guides to Teaching. 691-695
Bennett, Daphne M. Nicholson, Home Teaching of Young Deaf Children: A Pointer in Parent Education. 68-74
Bergmann, Margaret F. (see Trotter, William D.)
Biorn-Hansen, Vera, Social and Emotional Aspects of Aphasia. 53-59
Black, John W., Multiple-Choice Intelligibility Tests. 213-235
Black, John W. (see Morrison, Helen Miner)
Black, John. W., Scott N. Morrill, and Margaret Mary Malloy, The Pitch of Side-Tone. 339-342
Blackman, Ruth S. and R. Ray Battin, Case Study of Delayed Language. 381-384
Bloodstein, Oliver and Lois R. Schreiber, Obsessive-Compulsive Reactions in Stutterers. 33-39
Burk, Kenneth W. (see Diehl, Charles F.)

Carhart, Raymond, Problems in Military Audiometry: A CHABA Symposium. 5. Review of the 'Report by the Working Group on Military Audiometry.' 744-747
Carrow, Sister Mary Arthur, Linguistic Functioning of Bilingual and Monolingual Children. 371-380
Charan, Kirti K. and Robert Goldstein, Relation Between EEG Patterns and Ease of Eliciting Electrodermal Responses. 651-661
Chong, Lily Pao-Hu (see Wise, C. M.)

Davis, Hallowell and J. Richardson Usher, What Is Zero Hearing Loss? 662-690
Derbyshire, A. J. (see Goldstein, Robert)
Diehl, Charles F. and Kenneth W. Burk, Evaluation of a Special School for Speech Defective Children. 271-275

Fairbanks, Grant, Newman Guttman and Murray S. Miron, Auditory Comprehension in Relation to Listening Rate and Selective Verbal Redundancy. 23-32
Fairbanks, Grant, Newman Guttman and Murray S. Miron, Auditory Comprehension of Repeated High-Speed Messages. 20-22
Fairbanks, Grant, Newman Guttman and Murray S. Miron, Effects of Time Compression upon the Comprehension of Connected Speech. 10-19
Fattu, Nicholas A. (see Kapos, Ervin)
Flanagan, James L., Difference Limen for Formant Amplitude. 205-212
Frick, James V. (see McDonald, Eugene T.)

Glasner, Philip J. and David Rosenthal, Parental Diagnosis of Stuttering in Young Children. 288-295
Glorig, Aram, Problems in Military Audiometry: A CHABA Symposium. 7. Practical Limitations in Military Audiometry. 750-751
Goldstein, Robert (see Charan, Kirti K.)
Goldstein, Robert and A. J. Derbyshire, Suggestions for Terms Applied to Electrophysiologic Tests of Hearing. 696-697
Gottsleben, Robert H. (see Schlanger, Bernard B.)
Greene, Margaret C. L., Speech of Children Before and After Removal of Tonsils and Adenoids. 361-370
Guttman, Newman (see Fairbanks, Grant)

Hedgecock, Leroy D., Recruitment in Ears with Abrupt Loss of Acuity for High Frequencies. 91-97
Hirsh, Ira J., Problems in Military Audiometry: A CHABA Symposium. 4. A Classification of Hearing Tests. 736-743
Hoople, Gordon, Problems in Military Audiometry: A CHABA Symposium. 3. Diagnostic Audiometry. 734-735
House, Arthur S., Analog Studies of Nasal Consonants. 190-204
Hutton, Charles (see Maraist, Jean Ann)

Johnson, Kenneth O., Problems in Military Audiometry: A CHABA Symposium. 2. Veteran's Compensations for Hearing Loss. 731-733

Kapos, Ervin and Nicholas A. Fattu, Behavioral Rigidity in Speech-Handicapped Children. 707-713
Knower, Franklin H., Graduate Theses in Speech and Hearing Disorders—1954. 104-112

Ladefoged, Peter, Use of Palatography. 764-774
Lerea, Louis, Progress in Speech Therapy in Relation to Personality. 254-260
Leutenegger, Ralph R., Adaptation and Recovery in the Oral Reading of Stutterers. 276-287
Lowell, Edgar L., Georgina Rushford, and Harriet Montague, Survey of Families Enrolled in the John Tracy Clinic Correspondence Course. 75-86

Malloy, Margaret Mary (see Black, John W.)
Maraist, Jean Ann and Charles Hutton, Effects of Auditory Masking Upon the Speech of Stutterers. 385-389
McCroskey, Robert L., Jr., Effect of Speech on Metabolism: A Comparison Between Stutterers and Non-Stutterers. 46-52
McDonald, Eugene T. and James V. Frick, Some Factors Which Influence the Frequency and Duration of Treatment Sessions. 724-728
Mecham, Merlin J., Bibliography of Publications on Speech and Hearing in Cerebral Palsy. 348-355
Miron, Murray S. (see Fairbanks, Grant)
Montague, Harriet (see Lowell, Edgar L.)
Moodie, Catherine E. (see Sherman, Dorothy)
Morley, D. E. (see Skatvedt, Marit)
Morrill, Scott N. (see Black, John W.)
Morrison, Helen Miner and John W. Black, Prediction of Missing Words in Sentences. 236-240
Murray, Elwood, The C. S. Bluemel Collection on Stuttering. 761-763
Myers, Cecil K., Noise Bands *vs.* Pure Tones as Stimuli for Audiometry. 757-760
Myklebust, Helmer R., Babbling and Echolalia in Language Theory. 356-360

O'Neill, John J., Recognition of Intelligibility Test Materials. 87-90

Postman, Leo and Mark R. Rosenzweig, Perceptual Recognition of Words. 245-253
Prestigiacomo, A. J., Plastic-Tape Sound Spectrograph. 321-327

Rosenthal, David (see Glasner, Philip J.)
Rosenzweig, Mark R. (see Postman, Leo)
Rushford, Georgina (see Lowell, Edgar L.)

Schlanger, Bernard B. and Robert H. Gottsleben, Analysis of Speech Defects Among the Institutionalized Mentally Retarded. 98-103
Schreiber, Lois R. (see Bloodstein, Oliver)
Shames, George H., Use of the Nonsense-Syllable in Articulation Therapy. 261-263
Sheehan, Joseph G. and Robert B. Voas, Stuttering as Conflict: I. Comparison of Therapy Techniques Involving Approach and Avoidance. 714-723
Sherman, Dorothy and Catherine E. Moodie, Four Psychological Scaling Methods Applied to Articulation Defectiveness. 698-706
Siegenthaler, Bruce M. (see Webb, Clarence E.)
Skatvedt, Marit and D. E. Morley, Cerebral Palsied Monovular Twins. 343-347
Sortini, Adam J., Skin-Resistance Audiometry for Preschool Children. 241-244
Street, Barbara Stansell, Hearing Loss in Aphasia. 60-67

The CHABA Council, Problems in Military Audiometry: A CHABA Symposium. 8. Audiometry in the Armed Forces. 752-756
Tolhurst, Gilbert C., Effects of Duration and Articulation Changes on Intelligibility, Word Reception and Listener Preference. 328-334
Trotter, William D. and Margaret F. Bergmann, Stutterers' and Non-Stutterers' Reactions to Speech Situations. 40-45

Usher, J. Richardson, Problems in Military Audiometry: A CHABA Symposium. 1. Introduction to the Presentations. 729-730
Usher, J. Richardson (see Davis, Hallowell)

Voas, Robert B. (see Sheehan, Joseph G.)

Webb, Clarence E. and Bruce M. Siegenthaler, Comparison of Aural Stimulation Methods for Teaching Speech Sounds. 264-270
Webster, John C., Problems in Military Audiometry: A CHABA Symposium. 6. Automatic Audiometry. 748-749
Williams, Dean E., A Point of View about 'Stuttering'. 390-397
Wise, C. M. and Lily Pao-Hu Chong, Intelligibility of Whispering in a Tone Language. 335-338

SUBJECT INDEX

ASHA

Convention

Formal Call for Papers. 3-4, 775-776
Report of the Convention. 143-187
Thirty-Third Annual Convention. 189, 424-438

General

Honors of the Association. 132-135
President. 131
President's Page. 113
Progress and Goals of the Association. (James Carrell) 5-9

EXPERIMENTAL PHONETICS

Acoustic Phonetics

Analog Studies of Nasal Consonants. (Arthur S. House) 190-204
Difference Limen for Formant Amplitude. (James L. Flanagan) 205-212
Intelligibility of Whispering in a Tone Language. (C. M. Wise and Lily Pao-Hu Chong) 335-338
Plastic-Tape Sound Spectrograph. (A. J. Prestigiacomo) 321-327

Auditory Feedback

The Pitch of Side-Tone. (John W. Black, Scott N. Morrill and Margaret Mary Malloy) 339-342

Communication Theory

Prediction of Missing Words in Sentences. (Helen Miner Morrison and John W. Black) 236-240

Intelligibility

Effects of Duration and Articulation Changes on Intelligibility, Word Reception and Listener Preference. (Gilbert C. Tolhurst) 328-334
Intelligibility of Whispering in a Tone Language. (C. M. Wise and Lily Pao-Hu Chong) 335-338
Multiple-Choice Intelligibility Tests (John W. Black) 213-235
Recognition of Intelligibility Test Materials. (John J. O'Neill) 87-90

Physiological Phonetics

Use of Palatography. (Peter Ladefoged) 764-774

General

Auditory Comprehension in Relation to Listening Rate and Selective Verbal Redundancy. (Grant Fairbanks, Newman Guttman, and Murray S. Miron) 23-32

Auditory Comprehension of Repeated High-Speed Messages. (Grant Fairbanks, Newman Guttman and Murray S. Miron) 20-22
Effects of Time Compression Upon the Comprehension of Connected Speech. (Grant Fairbanks, Newman Guttman, and Murray S. Miron) 10-19

HEARING (AUDIOLOGY)-CLINICAL

Audiometry

Noise Bands *vs.* Pure Tones as Stimuli for Audiometry. (Cecil K. Myers) 757-760
Problems in Military Audiometry: A CHABA Symposium. 1. Introduction to the Presentations. (J. Richardson Usher) 729-730
Problems in Military Audiometry: A CHABA Symposium. 2. Veteran's Compensations for Hearing Loss. (Kenneth Johnson) 731-733
Problems in Military Audiometry: A CHABA Symposium. 3. Diagnostic Audiometry. (Gordon Hoople) 734-735
Problems in Military Audiometry: A CHABA Symposium. 4. A Classification of Hearing Tests. (Ira J. Hirsh) 736-743
Problems in Military Audiometry: A CHABA Symposium. 5. Review of the 'Report by the Working Group on Military Audiometry.' (Raymond Carhart) 744-747
Problems in Military Audiometry: A CHABA Symposium. 6. Automatic Audiometry. (John C. Webster) 748-749
Problems in Military Audiometry: A CHABA Symposium. 7. Practical Limitations in Military Audiometry. (Aram Glorig) 750-751
Problems in Military Audiometry: A CHABA Symposium. 8. Audiometry in the Armed Forces. (The CHABA Council) 752-756
Skin-Resistance Audiometry for Preschool Children. (Adam J. Sortini) 241-244
Suggestions for Terms Applied to Electrophysiologic Tests of Hearing. (Robert Goldstein and A. J. Derbyshire) 696-697
What Is Zero Hearing Loss? (Hallowell Davis and J. Richardson Usher) 662-690

Disorders

Hearing Loss in Aphasia. (Barbara Stansell Street) 60-67
Recruitment in Ears with Abrupt Loss of Acuity for High Frequencies. (Leroy D. Hedgecock) 91-97

Hearing Aids

Skin-Resistance Audiometry for Preschool Children. (Adam J. Sortini) 241-244

Recruitment

Recruitment in Ears with Abrupt Loss of Acuity for High Frequencies. (Leroy D. Hedgecock) 91-97

Therapy

Home Teaching of Young Deaf Children: A Pointer in Parent Education. (Daphne M. Nicholson Bennett) 68-74
Progress in Speech Therapy in Relation to Personality. (Louis Lerea) 254-260
Survey of Families Enrolled in the John Tracy Clinic Correspondence Course. (Edgar L. Lowell, Georgina Rushford, and Harriet Montague) 75-86

HEARING (AUDIOLOGY)-EXPERIMENTAL

Psychoacoustics

The Pitch of Side-Tone. (John W. Black, Scott N. Morrill and Margaret Mary Malloy) 339-342

General
Relation Between EEG Patterns and Ease of Eliciting Electrodermal Responses. (Kirti K. Charan and Robert Goldstein) 651-661

JOURNAL DEPARTMENTS

Abstracts. 114-130, 299-312, 401-419, 786-804
Book Reviews. 296-298, 398-400, 777-785
Graduate Theses in Speech and Hearing Disorders—1955. (Franklin H. Knower) 104-112
Index to Volume 22, *Journal of Speech and Hearing Disorders*. 809-815.
News and Announcements. 136-142, 313-319, 420-423, 805-808

LANGUAGE

Delayed Speech
Analysis of Speech Defects Among the Institutionalized Mentally Retarded. (Bernard B. Schlanger and Robert H. Gottsleben) 98-103
Case Study of Delayed Language. (Ruth S. Blackman and R. Ray Batin) 381-384

Speech and Language Development
Analysis of Speech Defects Among the Institutionalized Mentally Retarded. (Bernard B. Schlanger and Robert H. Gottsleben) 98-103
Babbling and Echolalia in Language Theory. (Helmer R. Myklebust) 356-360
Linguistic Functioning of Bilingual and Monolingual Children. (Sister Mary Arthur Carrow) 371-380

General
Perceptual Recognition of Words. (Leo Postman and Mark R. Rosenzweig) 245-253

PROFESSIONAL INTERESTS

General
Progress and Goals of the Association. (James Carrell) 5-9

SPEECH PATHOLOGY

Aphasia
Hearing Loss in Aphasia. (Barbara Stansell Street) 60-67

Articulation
Four Psychological Scaling Methods Applied to Articulation Defectiveness. (Dorothy Sherman and Catherine E. Moodie) 698-706
Speech of Children Before and After Removal of Tonsils and Adenoids. (Margaret C. L. Greene) 361-370

Cerebral Palsy
Bibliography of Publications on Speech and Hearing in Cerebral Palsy. (Merlin J. Mecham) 348-355
Cerebral Palsied Monovular Twins. (Marit Skatvedt and D. E. Morley) 343-347

Examination and Evaluation
Four Psychological Scaling Methods Applied to Articulation Defectiveness. (Dorothy Sherman and Catherine E. Moodie) 698-706

Stuttering
A Point of View About 'Stuttering'. (Dean E. Williams) 390-397

STATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCE
LIBRARY
JAN 10 1958
MANHATTAN
KANSAS

Adaptation and Recovery in the Oral Reading of Stutterers. (Ralph R. Leutenegger) 276-287
Effects of Auditory Masking Upon the Speech of Stutterers. (Jean Ann Maraist and Charles Hutton) 385-389
Effect of Speech on Metabolism: A Comparison Between Stutterers and Non-Stutterers. (Robert L. McCroskey, Jr.) 46-52
Obsessive-Compulsive Reactions in Stutterers. (Oliver Bloodstein and Lois R. Schreiber) 33-39
Parental Diagnosis of Stuttering in Young Children. (Philip J. Glasner and David Rosenthal) 288-295
Stutterers' and Non-Stutterers' Reactions to Speech Situations. (William D. Trotter and Margaret F. Bergmann) 40-45
Stuttering as Conflict: I. Comparison of Therapy Techniques Involving Approach and Avoidance. (Joseph G. Sheehan and Robert B. Voas) 714-723
The C. S. Bluemel Collection on Stuttering. (Elwood Murray) 761-763

Voice
Speech of Children Before and After Removal of Tonsils and Adenoids. (Margaret C. L. Greene) 361-370

General
Analysis of Speech Defects Among the Institutionalized Mentally Retarded. (Bernard B. Schlanger and Robert H. Gottsleben) 98-103
Behavioral Rigidity in Speech-Handicapped Children. (Ervin Kapos and Nicholas A. Fattu) 707-713

SPEECH THERAPY

Aphasia
Social and Emotional Aspects of Aphasia. (Vera Biorn-Hansen) 53-59

Articulation
Comparison of Aural Stimulation Methods for Teaching Speech Sounds. (Clarence E. Webb and Bruce M. Siegenthaler) 264-270
Use of the Nonsense-Syllable in Articulation Therapy. (George H. Shames) 261-263

Cerebral Palsy
Bibliography of Publications on Speech and Hearing in Cerebral Palsy. (Merlin J. Mecham) 348-355
Progress in Speech Therapy in Relation to Personality. (Louis Lerea) 254-260

Cleft Palate
Progress in Speech Therapy in Relation to Personality. (Louis Lerea) 254-260

Stuttering
A Point of View about 'Stuttering.' (Dean E. Williams) 390-397
Stutterers' and Non-Stutterers' Reactions to Speech Situations. (William D. Trotter and Margaret F. Bergmann) 40-45
Stuttering as Conflict: I. Comparison of Therapy Techniques Involving Approach and Avoidance. (Joseph G. Sheehan and Robert B. Voas) 714-723

General
Children as Guides to Teaching. (Jane E. Beasley) 691-695
Evaluation of a Special School for Speech Defective Children. (Charles F. Diehl and Kenneth W. Burk) 264-270
Progress in Speech Therapy in Relation to Personality. (Louis Lerea) 254-260
Some Factors Which Influence the Frequency and Duration of Treatment Sessions. (Eugene T. McDonald and James V. Frick) 724-728